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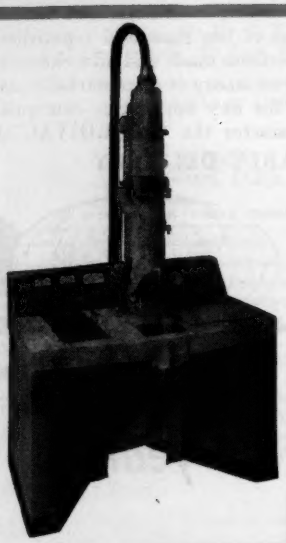

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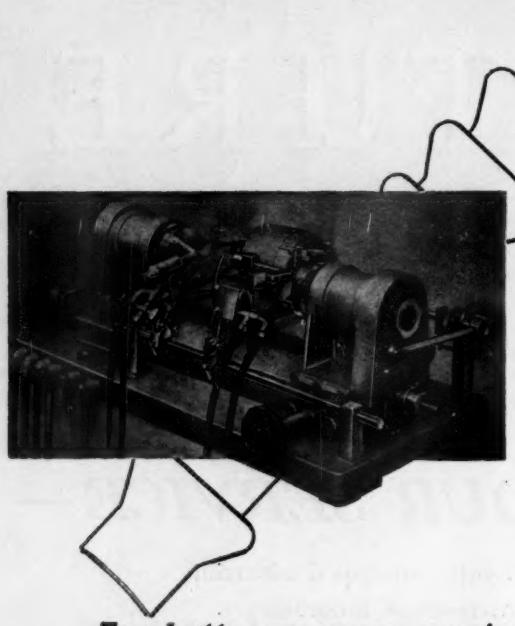

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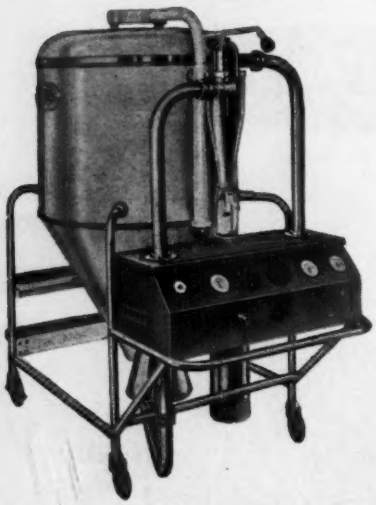

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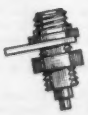

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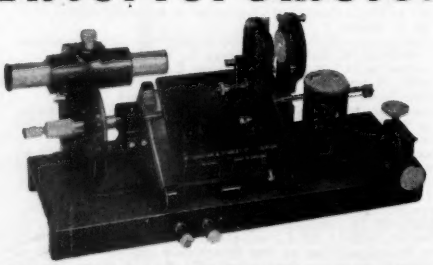

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QUALITY IN TECHNICAL EDUCATION

RATHER less than three years ago a study of Soviet professional man-power was published by Mr. Nicholas De Witt in the United States under the auspices of the National Academy of Sciences – National Research Council, with the support of the National Science Foundation. The annual reports of the National Science Foundation have since borne witness to continuing concern in the United States at the shortage of scientific man-power and of science teachers in particular. Anxiety on these points was further stimulated by the success of Russian efforts at launching an artificial Earth satellite; and President Eisenhower's recent message on education indicated that, apart from any question of comparison with the U.S.S.R., the Government of the United States is determined to rectify some acknowledged weaknesses in the American educational system as a whole.

In these circumstances, the comprehensive survey of Soviet education, with special emphasis on science and technology, by Mr. A. G. Korol, which the Massachusetts Institute of Technology has recently issued, is of widespread interest in the United States*. It is of no less interest to British readers in the context of the expansion of technical and technological education and our own shortage of teachers of science and mathematics. As Dr. M. F. Millikan, director of the Centre for International Studies, Massachusetts Institute of Technology, where the project from which the book arose was begun in 1953, points out, Mr. Korol attempts to examine the organization and effectiveness of the Soviet formal training process in science and technology and to bring out its implications for the general quality of scientists and engineers trained in the U.S.S.R. It is concerned with quality rather than numbers, and to throw light on the probable quality of the present and future generations rather than on that of the past.

To measure the quality of Soviet education, Mr. Korol relies on two techniques. First, material used in Soviet schools was collected and submitted for examination to American educationists in the relevant fields, more especially in physics and mechanical engineering. Analysis of the content of Soviet textbooks, examinations, syllabuses and curricula at different levels of the educational system permitted inferences to be drawn regarding the breadth and depth of the Soviet student's knowledge and skill. Secondly, since specialized training for science and engineering cannot be considered intelligently without an understanding of the philosophy and organization of the system of higher education and of the general and specialized education which precedes it, Mr. Korol made a careful analysis of the entire Soviet system of higher education.

The book is not a comparative study, and its scope is limited in the way already indicated. Its opening chapters consider, successively, the Soviet organization of secondary education up to the secondary level, touching upon the major alternatives to academic advancement, the ten-year school (the Soviet counterpart of the American twelve-grade system from elementary to high school), and that sector of the Soviet system which includes many so-called technicums and other specialized schools which train students for work in various fields at the sub-professional level. The major part of the book is devoted to Soviet undergraduate higher education, and curricula in physics and in mechanical engineering are compared in detail with those most nearly equivalent at the Massachusetts Institute of Technology.

These chapters, and a further chapter in which comments are made on the organization and conduct of postgraduate training, throw light on such important questions as how many and what kinds of students receive a higher education, and how they are drawn into the special fields of particular interest to the Soviet State; what shortages at various levels of school facilities or of appropriately trained teachers are likely to affect the quality of Soviet education for science and technology; and how Soviet educational philosophy and practice are evolving to meet the rapidly changing requirements of an industrialized society. These are all questions the answers to which may be suggestive in the entirely different context of American and British education, and it is a great merit of Mr. Korol's study that he brings out so clearly the dependence of the aims and characteristics of Soviet education on the character and purpose of the Soviet State. They are rooted in the nature of a totalitarian system as opposed to a democratic system.

For this reason Mr. Korol's final chapter of comments and reflexions on Soviet education is perhaps the most important and stimulating, as it is certainly the chapter of the widest interest. The rationale and aims of Soviet education, he insists, reflect inevitably the basic Communist view of society and the place the individual occupies in it. The two fundamental facts of the Soviet educational system are the prescription of national maximum admission quotas and the assurance that all designated quotas are filled. With these, and arising from the capacity of dictatorship to move by decree in meeting changing circumstances and needs, ever since the formulation of the first Five Year Plan in 1928 technical training and other professional education in selected fields important to an industrial society have been energetically developed and are now conducted on a massive scale. Next, and most important, the ends of

* Soviet Education for Science and Technology. By Alexander G. Korol. (Technology Press Books in the Social Sciences.) Pp. xxv+513. (Cambridge, Mass.; Technology Press of the Massachusetts Institute of Technology; New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1957.) 68s.

Soviet education have not been modified since the inception of the regime, and the organization and content reflect two dominant objectives: first, to inculcate a complete commitment to the will and ways of the Communist Party; and secondly, to develop maximum technical competence for work in designated occupations and capacities.

Mr. Korol refers freely to Mr. De Witt's study; but his book is concerned much more closely with the question of quality and, apart from its warning as to the danger of preoccupation with numerical comparisons between systems with such widely differing characteristics and objectives, his book is the more useful for directing attention to lessons that we might learn in planning the expansion of technical and technological education in Britain. Soviet achievement in education, he remarks, is of somewhat less heroic proportions than the undifferentiated gross statistics imply, and the Soviet educational system cannot be understood without taking into account the power of the Soviet dictatorship to allocate national resources, including intellectual resources, to its own ends. Every trained individual is obliged to work in a designated capacity and location for a number of years (in practical terms, indefinitely) after completing training.

This central control explains both the major strength and the major weaknesses of the system. Among the elements of strength are the power to enforce decisions, to allocate resources, to co-ordinate the component parts of the educational system into a ladder and, perhaps the most important qualitatively, the mechanism for establishing a minimum standard, at least formally, for schools at every level and every kind. With this goes increased deferred costs and liabilities, progressively increasing difficulties of accurate planning, unprecedented growth of bureaucracy, the possibility of major blunders of policy on a national scale, and the progressive paralysis of individual initiative, which has been spreading through the entire Soviet educational fabric.

These are formidable drawbacks, and should give pause to all those who in Great Britain are seeking to enforce uniformity at any level. Variety of type and experience and freedom to experiment are solid assets which we impair or relinquish at our peril. Moreover, while Mr. Korol sees signs of attempts, within the unchanged administrative and organizational setting, to broaden the critical basis of training in engineering, to encourage independent work and reduce the emphasis on established practices and existing technology, which could substantially increase the versatility and competence of the future generation of young Soviet engineers, he sees limited success for such efforts within the rigid structure of the Communist system.

Here, in recapitulating his evaluation of the Soviet education system in terms of the three major variables, Mr. Korol brings out the fundamental nature of its challenge to Britain as much as to the United States. The Soviet criteria of quality are based on specialized knowledge, largely in its technical and manipulative aspects, in which technical sense the quality has been high. Quantitatively, the Soviet Government trains only as many as it thinks it needs to train, not as many as desire training and are capable of advancement. As to motive, the significant elements of its strength are indoctrination, which is not education, and the inducements of a steeply progressing scale of rewards in terms of social status and purchasing power.

The contrast on all three counts with the ideals and practice in Britain need not be further stressed here; indeed, Mr. Korol suggests that the real challenge of the Soviet system is not in numbers but in the degree to which national education and training efforts and performance are consonant with national goals. We must see that the scale, character, flexibility, vigour and quality of our educational system are commensurate with expanding responsibilities and goals. It is by their contribution to that end that education policy and proposals for the expansion of university, technological, technical or secondary education must be judged. In the long run, Mr. Korol argues, the threat of Communism will be removed if the free peoples continue vigorously to pursue their highest social goals, and to maintain their combined scientific, technological and moral achievements.

In that sentence Mr. Korol both challenges any complacency and sets the problem of educational expansion and development at any level in the context of Anglo-American co-operation and our common security. The problem, in Britain as in the United States, is to determine how to divert from non-essential uses to those essential purposes the required larger proportion of material resources and man-power, without in the process damaging the characteristics of a free people and endangering the initiative and respect for individuality upon which so much of our real strength and scientific progress and creative work alike depend. As Dr. Millikan has reminded us, we cannot accept the criteria applied in the U.S.S.R. We must hold fast our own conception of the functions of education, and not be led astray into an attempt to see whether we can increase the proportion of scientists and technologists and technicians in our population. The central issue is whether we can improve still further the quality of the scientific and technical training which we give them, and whether their general education can be made such as to enable them to take their place more effectively in the modern world. Put in another way, it is whether we can find better methods consistent with our democratic principles for focusing the attention of the best scientific minds on the critical technical problems of defence and development; and from yet another angle, it is one of the efficient administration of research and development and the wise and effective use of scientific and technical man-power. Britain and the United States alike should be grateful to Mr. Korol for directing attention to this issue of quality, and exposing the futility of the numerical comparisons and consequent danger of misdirected effort and waste.

HUMANISTIC PSYCHOLOGY

Humanistic Psychology

By Prof. John Cohen. Pp. 206. (London: George Allen and Unwin, Ltd., 1958.) 18s. net.

THE history of Western psychology from Greek times onwards can be regarded as a series of attempts to study the human mind by the methods of the natural sciences, punctuated by periodic protests regarding the validity and fruitfulness of such attempts. Socrates protested against the analytical methods of the Ionians. It was he, Socrates, not the machinery of his bodily organs, who was responsible for his conduct and behaviour. The psychology of Hobbes brought forth the protests of Cudworth and the Platonists. Coleridge in "Biographia Literaria" expounds the reasons which led him to reject the physiological psychology of Hartley, thus initiating the idealistic reaction against British analytical psychology which was to come to a head later in the nineteenth century. James Ward, in his famous article in the ninth edition of the "Encyclopædia Britannica", rejected a physiological approach to psychology, which advances in the physiology of the brain and nervous system had rendered increasingly attractive. The experimental psychology of the Wundtian period in Germany produced its counterblast in the influential 'understanding' psychology of Dilthey. To-day, on both sides of the Atlantic voices are being raised against the dominant modern trends in psychology, against the adequacy of physiological models, against conditioning theory, cybernetical concepts and quantitative methods. Prof. J. Cohen's book on "Humanistic Psychology" is the latest of these protests, and like most of its predecessors it shows strongly the marks of Continental influences and a certain aversion to Anglo-Saxon empiricism.

The book is a lively, if somewhat miscellaneous, collection of essays, in no way as the preface suggests a 'text', loosely held together by a common point of view. Cohen holds that the qualities of human experience are peculiar to themselves, cannot be reduced to the activities of the nervous system, and must be experienced from within. Man has a history as well as a nature, and he must be studied by appropriately humanistic methods. Cohen illustrates this theme by essays on childhood, the senses and psychological time, personal and group factors in thinking, and some miscellaneous papers on the psychology of work, illness and literature. The emphasis all through is on the richness, variety and incommensurability of inner experience, on that which remains over when physiology has done its best to explain, and on the need for a sensitive imagination if the psychologist is not to miss all this.

What the author has to say is interesting, stimulating and, in the best sense of the word, provocative. Let us be clear, however, that in spite of the references to empirical research and in spite of Prof. Cohen's own contributions to such research, this is not scientific psychology, nor a substitute for scientific psychology. It is too arbitrary and too much dependent on subjective insight. Views not unlike those of Prof. Cohen have brought to virtual ruin the not unimpressive edifice of German psychology. The scientific psychologist will continue his plodding way regardless of Prof. Cohen's barbed humanistic sallies. And quite rightly; for a scientific psychology must be firmly based on an adequate understanding of elements and fundamentals. It cannot start 'on the heavenly plane', as Prof. Cohen seems to desire.

But Prof. Cohen's protest, like earlier protests, has its value even for scientific psychologists. For it may save them from that complacency in the adequacy of their theories and methods into which they so often fall. It is good that from time to time their attention should be directed to the wide gap which exists between what psychology has yet achieved and the manifest richness of human nature, to which the scientific psychologist is frequently blind. Prof. Cohen does this, and in doing so has written a witty and vivacious book which is a pleasure to read.

L. S. HEARNSHAW

NEUROBIOLOGY

Morphologie und Physiologie des Nervensystems

Von. Prof. Paul Glees. Pp. xii+445. (Stuttgart: Georg Thieme Verlag, 1957.) 58 D.M.

THE author describes this text-book as an attempt to organize the most important results of experimental neurology in a form suitable for readers interested in neurology and neurobiology. A valuable feature is its emphasis on neuroanatomy, the author's own subject, though his interests range far into neurophysiology.

The latter subject naturally falls into three sub-groups: (1) the traditional problems of localization which seek static answers and are intimately concerned with the anatomy of centres and pathways; (2) a dynamic variety dealing with circuit analysis, functional principles or, more generally, with problems of 'how' as opposed to those of 'where'; and (3) applied physico-chemistry elucidating in terms of the concepts of these sciences events which take place across membranes in nerves, synapses, end plates, etc.

Prof. Glees's references will help readers interested in these three fields to much of the relevant literature, even when the author himself is less fortunate in presenting leading ideas and has to be content with loosely connected facts. This criticism applies to the fields enumerated under (2) and (3), which are difficult to discuss interestingly without the background of a great deal of thought-provoking experimental activity. Since most of the work in these fields concerns structures below the brain stem, Prof. Glees's book does not really gather momentum until he has reached the level of the mid-brain, except when treating histology. It is, for example, still curiously disintegrated on the subject of the spinal cord.

The physiology of the brain is dominated by the first sub-group mentioned above, that is classical problems of localization which do not necessarily become neurophysiology in the stricter sense, merely because methods of degeneration and surgical removal have to some extent been supplanted by electrical equivalents, such as the method of 'evoked potentials' and other varieties of electrical recording and stimulation. On the other hand, the problems of localization are important in themselves, particularly when related to physiological points of view. Concepts used in this field are easily understood, while circuit analysis is still much concerned with the development of an appropriate arsenal of useful analytical notions.

In dealing with problems of localization the experimenter asks, for example, what parts of the brain are necessary for feeling thirst, hunger, for sleep and wakefulness, to what parts visual, acoustic and tactile

impulses go, and in what ways the peripheral receptive fields are projected, or what disabilities performance tests disclose after certain operations, etc. Complex interconnexions such as those between hypothalamus and the pituitary gland require a firm histological basis as a first step towards establishing functional interaction.

In this general field of research to which Prof. Glees himself has contributed valuable information he is also a good guide. These sections, the leading ones in the book, are accompanied by excellent anatomical diagrams and describe the modern work in an easy, fluent style. Briefly the book is best described as an introduction to recent advances in the morphology and physiology of the brain. In this sense it is complete in its treatment of the facts and ideas that have been advanced during the past twenty years.

Ragnar Granit

STRESS AND ADAPTATION

The Stress of Life

By Dr. Hans Selye. Pp. xx+324+7 plates. (London and New York: Longmans, Green and Co., Ltd., 1957.) 18*s*.

PROF. H. SELYE'S book is an attempt to give an account of his concepts of stress and adaptation for the general reader. It is perhaps scarcely to be expected that one should find in it rigid definitions and deductions. The method he uses is more impressionistic and is illustrated with allusion and metaphor rather than by tabulation of data. Nevertheless, there are passages of some interest where he seeks for definitions, for example, "*stress is the common denominator of all adaptive reactions in the body*. This is simple and true, but perhaps still too vague". Later, "STRESS IS A STATE MANIFESTED BY A SYNDROME . . ." (*sic*) and "The condition of biologic stress is essentially an adjustment". Such samples of the method of typography, discussion and definition illustrate the characteristic empirical, as it were non-logical, approach. The italics and capitals are a sort of substitute for definition, warning one not to ask such questions as whether a 'state' can be an 'adaptation', and so on.

Certainly, the method allows the presentation of many interesting points of view about the whole subject of "adaptability, or *adaptation energy*", of which "it is as though we had hidden reserves in the body". The subject is such a challenging one and so much neglected that any discussion is welcome. Prof. Selye's treatment is, of course, that of an endocrinologist; he sees the mechanisms of adaptation in terms of a hormonal system, centring on the pituitary. No doubt he would be the first to admit that this system of mammals shows, in a specialized form, reactions that are common to all life. Within the framework of his system he considers inflammation, arteriosclerosis and a long list of diseases of adaptation, including nervous and mental diseases and sexual derangements. Indeed, it is difficult to avoid feeling that his concepts are so wide that they include too much. Perhaps it is not fair to blame this entirely on Prof. Selye. Adaptation is an omnipresent and mysterious phenomenon, and yet we have no adequate concepts for dealing with it. One may sympathize with the conclusions of his final discussion that there is need for a "new type of medicine", but it is doubtful if this can be supplied only by the endocrinologist, however long his list of specific substances and hormones.

J. Z. Young

STATIONARY TIME SERIES

Statistical Analysis of Stationary Time Series

By Dr. Ulf Grenander and Prof. Murray Rosenblatt. (Wiley Publication in Mathematical Statistics.) Pp. 300. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.; Stockholm: Almqvist and Wiksell, 1957.) 88*s*. net.

ANALYSTS of stationary time series tend to fall into one of two groups. One prefers to express the properties of the series in terms of its autocorrelation structure; the other uses the periodogram or the spectrum. Seeing that the results of one method can be transformed by a Fourier analysis into the results of the other it might have been supposed that the 'complete analyst' would use either, according to convenience. But in general, this is not so, and there is a good reason for it. The basic models studied by autocorrelation methods are such that in general no underlying periods in the strict sense exist as, for example, in economics; those studied by spectral analysis are more concerned with harmonic components, as, for example, in engineering and the physical sciences.

This book by Grenander and Rosenblatt is concerned mainly with spectral analysis. It begins with an account of stationary stochastic processes and the analysis of parametric models; proceeds to problems of estimation of the spectrum and the sampling distribution of spectral estimates; and concludes with problems in linear estimation and some assorted topics of a related nature. The examples are drawn mainly from the physical sciences—optics, turbulence and ocean waves. There are about fifty exercises, a six-page appendix on complex variable theory and a bibliography.

The statistical problems which arise in the analysis of time series are truly formidable and in several ways require techniques which are not familiar to many statisticians. It is accordingly very useful to have this unified treatment of the spectral approach. The authors, noting that existing literature is characterized by a certain lack of precision, have devoted a good deal of space to rigorous mathematical proofs. This, it must be admitted, makes the book rather difficult reading; but then it is a difficult subject, and one applauds their willingness to make assumptions which would be restrictive to a mathematician seeking complete generality but are no limitation so far as concerns practical applications.

In one respect the ideas advanced in the book will require further consideration. Most models used for the study of time series depend only on a finite number of parameters. The authors feel that the estimation of the spectrum is a better approach because it contains an infinity of parameters and hence provides a method of greater generality. But the estimates to which it leads are much less precise, and, as the authors themselves point out, any good estimate of the spectral density is biased. For long series such as occur in physics this may not be serious; but for economics it is fatal, even if (which is not the case) the spectral density could be given an interpretation. It remains to be seen, in some subjects at least, whether the spectral approach may not have the wraith-like quality suggested by its name.

Nevertheless, this is a useful book and should form a normal part of the time series analyst's equipment.

M. G. Kendall

WATER-HAMMER ANALYSIS

Waterhammer Analysis

By John Parmakian. (Prentice-Hall Civil Engineering and Engineering Mechanics Series.) Pp. xiv+161. (Englewood Cliffs, N.J.: Prentice-Hall, Inc.; London: Longmans, Green and Co., Ltd., 1955.) 45*s*. net.

THE term 'water-hammer' is used to describe the pressure variations in water conduits due to a change in the rate of flow as the result of altering the opening of a valve or the gate of either a water turbine or a pump. The control of water-hammer is often a major problem in the design of those hydro-electric installations in which the turbines are fed from a head pond through closed conduits such as tunnels and pipelines. When a generator accepts or rejects load, the water intake by its turbine must be increased or decreased, respectively. The rate at which these changes of flow are allowed to take place is dictated by considerations of water-hammer, having regard to the strength of the water conduit for withstanding pressure variations and avoidance of the hazards attendant upon separation in the water column due to excessive reduction of pressure. It is not surprising, therefore, that impetus to the study of water-hammer was given by pipeline failures in some of the early Continental hydro-electric installations and it is to the Italian Allievi (1903) that the modern theory of water-hammer is due. More recently, Schnyder and Bergeron made an important contribution to the practical use of the theory of water-hammer by providing the graphical method with which this book, which is written for the student as well as the practising engineer, is mainly concerned.

The first chapter deals with the approximate theory of water-hammer in which the pipe and water column are assumed to be inelastic or rigid. This theory, which is of very limited utility, is followed by the more accurate elastic water column (pressure wave) theory in Chapter 2. The effect of the elastic properties of pipe materials upon the velocity of pressure waves, pressure wave reflexion and pressure variations caused by the extremes of rapid and slow regulation of flow are considered in Chapters 3, 4, 5 and 6, respectively.

The theory of the powerful and general graphical treatment of the water-hammer equations of the elastic theory is given in Chapter 7. This graphical approach, due to Schnyder and Bergeron, which brought the accurate analysis of water-hammer phenomena within the competence of the non-specialist, revolutionized water-hammer analysis. By its use, tedious calculations are circumvented by a simple, repetitive graphical process. Various applications of this method are dealt with in subsequent chapters. Thus, its use for the analysis of water-hammer due to both partial and complete closure or opening of the flow regulator during finite intervals of time and water-hammer in pump discharge lines due to various causes, such as failure of the pump motor and the presence of non-return valves, are considered in Chapters 8–12.

The effect of hydraulic losses on water-hammer is the subject of Chapter 13 (these losses reduce the magnitude of water-hammer effects), while application of the graphical method to the analysis of water-hammer in pipelines with branches is dealt with in Chapter 14. Finally, approximate methods of graphical analysis and the theory of surge chambers and air vessels for limiting water-hammer in turbine pipelines and pump discharge lines, respectively, are considered briefly.

There is, in addition to the eighteen chapters, a list of forty-seven references to previous work and a number of problems for solution, with answers.

The book is clearly written and illustrated and is a useful addition to the few existing books in English which deal with this aspect of engineering science.

T. M. CHARLTON

A MODERN PIDDUCK

Electricity and Magnetism

By B. I. Bleaney and B. Bleaney. Pp. xiv+676. (Oxford: Clarendon Press; London: Oxford University Press, 1957.) 63*s*. net.

AS a physics student at Oxford in the late 'thirties, the reviewer was advised to use the late Dr. F. B. Pidduck's "Treatise on Electricity". In the quite probable event that a modern Oxford student might be recommended to use the new treatise by Prof. and Mrs. Bleaney, the difference will illustrate how the subject—and undergraduate courses—have grown in twenty years. The authors have surely had to condense at least double the amount of matter into their book, and they have done it in about the same number of pages. Indeed, the first impression which I had of this book was that it was in many ways a modern Pidduck, with the supreme virtue of conciseness of that book. Every sentence counted in Pidduck (there were some examination questions which could be answered if one remembered the right few lines of Pidduck) and the same is even more true of Bleaney and Bleaney.

It seems inevitable that this will be the standard text for many years for undergraduate courses. It has the advantage over another good and much-used text, Harnwell's "Principles of Electricity and Electromagnetism", that it is nearly fifteen years newer, and there are few other serious competitors. The range covered is that of the modern honours course, treated fully and generously. But to say this is to miss the outstanding feature of the book, which is the way in which it has assimilated, selected and presented the developments of the past 20–30 years without losing the didactic virtues of classical methods of teaching electricity and magnetism. For example, in the same chapter there are described the quadrant electrometer and the Van de Graaff generator. In a chapter mainly devoted to a formal account of the magnetic effects of currents there are described the mass spectrograph and the cyclotron.

In later chapters dealing with the microscopic electrical and magnetic properties of matter very much of the material is new physics and it is in these chapters that the selection of matter is so good. It must have been difficult to decide how much to write about, say, magnetic resonance, but in almost every respect the authors have chosen well. Not only do they cover the range of a modern honours course but they seem to me to define what a good honours course should contain in this subject.

There are many pleasing details to notice. For example, there are a very good account of the design of magnets and a real explanation of how a cell works. At the end of each chapter there are good examples, both searching and relevant. Naturally there are some misleading points in the book, and others with

which a particular reviewer would disagree; some fundamental points, such as the definition of **D** and **E**, are given rather cavalier treatment. In dealing with thermo-electricity, Kelvin's treatment is still given although a reference to Onsager would now be more appropriate. D.c. and a.c. circuits are given a good deal less attention than they deserve to-day, and some quite important matters are dealt with either only in the examples following each chapter (Kelvin double bridge, Thévenin's theorem) or not at all (a.c. potentiometer). There is a certain unpredictability about the way in which references are given, and leading references for further reading are rather sketchy.

The rationalized M.K.S. system is used throughout and it is pleasing to note that the authors do not make a fuss about this; indeed, units are scarcely mentioned until the last chapter. This is quite a salutary lesson for students of physics, although no doubt engineers have practical reasons for worrying about units.

I have the highest opinion of this new treatise, and consider that the authors have achieved a major work of selection, compression and exposition.

G. O. Jones

SOLID-STATE SCIENCE FOR THE ENGINEER

The Science of Engineering Materials

Edited by J. E. Goldman. Pp. xv+528. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1957.) 96*s*. net.

SHOULD an engineer need to know why the materials with which he works behave as they do? Or should he just accept their properties in the form of factual data from which to determine the use of those materials? Some such knowledge is essential for even the elementary understanding of some of the more modern engineering devices. Also any striking developments in materials are likely to come from worrying about what the atoms are doing.

The universities are waking up to the ever-increasing need for some solid-state physics to be introduced as part of the discipline in an engineering education, and some have already gone some way in this matter. The burning question is: How much can be put into a course? How much will the student be able to comprehend without letting his intake of other engineering subjects suffer?

This book is a collection of papers presented at a recent conference in the United States at which this topic was the theme. The papers, by a number of leaders in their own fields, dealt with aspects of solid-state science, including recent technical developments, which might well be considered to have a proper place in a university engineering curriculum. It is very ambitious in its scope, the amount of subject-matter presented calling for more time than could be spared in any normal three- or four-year course. Also some of the topics would be of interest only to the specialist engineer.

The first four chapters deal with the basic features of solid-state science—putting the reader in the picture for later chapters—and survey a wide field far too briefly to give a fair picture of the large amount of ground covered.

The Bohr theory of the atom, the Schrödinger wave mechanical equation for the hydrogen atom, the electronic structure of the atoms, the Periodic Table and the nature of the chemical bond are given in only 22 pages. The explanation of the intrinsic properties—elasticity, specific heat, conductivity, etc.—in terms of solid-state theory follows. The last of these four chapters shows how crystal imperfections account for diffusion in solids, semiconductors, etc.

The next six chapters are of fairly general interest, covering many points of physical metallurgy. Crystal structures, phase diagrams and elastic properties are explained in terms of the electron theory. Three of the chapters are devoted to dislocations, the interpretation of mechanical properties in terms of them, and the experimental evidence for their existence. A footnote refers to the more recent works of Dash and Hirsch which have demonstrated much more conclusively the existence of dislocations, and is evidence of up-to-date editing before publication.

The next chapter, on surface phenomena, is a mixed bag containing all-too-brief sections on friction and adhesion, adsorption and catalysis, corrosion and electron emission.

The remaining chapters are of a more descriptive nature and deal with specialized topics, but are sufficiently comprehensive to enable a non-specialist to become acquainted with them. These topics are magnetism, semiconductors, cement, glass and high polymers.

It will amply repay anyone wishing to plan a course on materials in an engineering curriculum to study this book, particularly the first half of it, as any topic dealt with in that part is worthy of consideration in such a course.

K. J. Pascoe

THE HEAVIEST ELEMENTS

The Chemistry of the Actinide Elements

By Joseph J. Katz and Glenn T. Seaborg. Pp. xv+508. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1957.) 63*s*. net.

THIS book is an authoritative and up-to date account of the chemistry of the elements from actinium (No. 89) to nobelium (No. 102). It is the first time that the whole field has been reviewed by the same authors, and the present ones are uniquely well qualified for the task. There are individual chapters on the occurrence, purification and chemistry of each element from actinium to curium, a chapter on the transcurium elements and a summary chapter. The only similar book previously available was Volume 14*A* of the National Nuclear Energy Series, published in 1954, which covered all the actinide elements then known in a series of review articles by different authors. Many sections have been expanded in the present book—for example, those on the geochemistry and extraction metallurgy of uranium and thorium and the section on magnetic properties. Three new elements have been added to the list and much new material has become available, including the large amount declassified and published in the proceedings of the International Conference at Geneva in 1955. All this has been incorporated in a shorter book by the omission of chapters on α- and fission-measurements and on optical properties, and by a less detailed discussion of much of the older literature. Concentration of the authorship has meant that this book gains greatly in coherence and in readability; the style is more that of a text-book than that of an exhaustive review, though the coverage is, in fact, excellent.

Those aspects of the chemistry and metallurgy of the early members of the series which are important to the technology of nuclear power are pointed out; the main purpose, however, is to give a scientific account rather than technical data. The position of these elements in the Periodic Table is discussed at length in the valuable summary chapter. The trivalent state is the characteristic valency of all elements beyond plutonium, and the relatively stable tetravalent state of berkelium is readily explained if the (5*f*) shell is half-filled at curium (No. 96), as is strongly supported by spectroscopic and magnetic evidence. It is only logical to group all the elements in a series starting with actinium, though thorium and protoactinium, the earliest two members, show few of the expected properties of a (5*f*) series. Similarities and differences between the lanthanide and actinide series are treated fully. The chief difference is the stability of the higher oxidation states of the earlier actinide elements, which leads to a far more complex chemistry, both in the solid state and in solution; a feature of the book is the detailed account of the solution chemistry of uranium and plutonium. The availability of the different isotopes and the difficulties caused by the intense α-activity of many of them are discussed.

This book will be primarily useful to research workers in this and allied fields of chemistry; it is good to know that the authors intend to keep the work up to date in later editions. It will come to be regarded as the standard text in this subject, and it can be recommended to all advanced students of inorganic chemistry. The printing is good and the price is not excessive. L. E. J. ROBERTS

MAMMALIAN DEVELOPMENT

Parthenogenesis and Polyploidy in Mammalian Development

By R. A. Beatty. (Cambridge Monographs in Experimental Biology, No. 7.) Pp. xii+132+2 plates. (Cambridge: At the University Press, 1957.) 15*s*. net.

ON his own, and in collaboration with Dr. M. Fischberg, Dr. R. A. Beatty has published numerous papers relating chromosome number and developmental possibilities in the initial phases of embryogenesis. These researches have led him to examine the problem of parthenogenesis which, as we know, is closely linked to that of polyploidy.

Dr. Beatty reviews the present state of knowledge in a short monograph that aims at comprehensiveness, but the brevity of which is a tribute to the author's successful efforts in condensing a considerable body of knowledge into little more than 100 pages. He has worked principally on mammals; in his book, therefore, they take first place. But the author bases his exposition throughout on observations and experimental findings obtained in other zoological groups, particularly the Amphibia. This excellent method has the advantage of displaying the particular case of mammals with a more general context.

After an introductory chapter in which the various techniques in use are set out and discussed, the author examines sixteen possible 'routes' along which an oocyte or an egg can develop. Eight of them are apomictic, which means that they do not require the presence of a spermatozoon; we are concerned here with various types of parthenogenesis—haploid, diploid, tetraploid or octaploid. These four principal categories can be subdivided according to the cytological behaviour of the oocyte; for example, development would be diploid for a diploid oocyte that had emitted only a single polar body, and equally diploid for an originally tetraploid oocyte that had emitted two polar bodies, thus reducing it from the number $4n$ to the number $2n$. Having established this classification, the author goes through the various zoological groups in which one or other of the developmental types exists, and he examines the experimental production of each type. In mammals, it is thermal shock that has given the best results.

Next comes an analysis of eight amphimictic routes in which the initiation of development is associated with the presence of a spermatozoon. According to whether the oocyte is haploid (as in a normal fertilization) or not, the egg will be diploid, triploid, tetraploid, hexaploid or decaploid. It is interesting to note that embryogenesis can still occur in embryos the nucleoplasmic relationships of which have been profoundly modified.

Each of these combinations involves some general genetic consequences. Furthermore, sex, which can as we know depend on an equilibrium between the autosomes and the sex chromosomes, is a function of the chromosomal constitution of the embryo. Here again, Dr. Beatty presents a very clear and practical systematization of the various eventualities.

The problems relating to polyploidy in mammals are of great interest. In the mouse (Beatty and Fischberg) and in the rat (Austin and Braden), a thermal shock (45° C.) inhibits the emission of the second polar body and, when the egg has been fertilized, triploidy in the embryo is the result. Häggqvist and Bane, using colchicine, attempted to obtain adult triploid rabbits. But it must be admitted in this latter case that the cytological assessment carried out by Melander did not allow of any formal conclusions. With the pig, in which the Swedish authors claim the production of a triploid individual, the cytological analysis did not furnish a proof. While it is certain that triploid embryos of the mouse have been obtained in abundance by Beatty and others, it does not yet seem to be proved that the development of a triploid mammal can continue up to birth, let alone to adulthood.

Has polyploidy played a part in the chromosomal evolution of mammals? Several authors, particularly Darlington and Gates, answer this question in the affirmative. In the palæarctic Cricetinae, there exist species with 22 chromosomes and species with 44. Struck by this simple numerical relationship, Darlington has postulated that *Mesocricetus* ($2n = 44$) arose from an interspecific cross between *Cricetus* and *Cricetulus*, each with 22 chromosomes, with a polyploidization superimposed. Beatty, like White and Matthey, considers this hypothesis indefensible. I might add here, that to the numerous arguments which have been advanced against the hypothesis, I can now add another; there are Cricetinae with 20 chromosomes (*Cricetulus barabensis*), with 26 (*Allocricetulus*) and with 28 (*Phodopus*). This emphasizes that it is a simple coincidence that the two species which happened to have been studied first should have displayed a simple reciprocal relationship in their chromosome number.

The presentation and the choice of material in this monograph are excellent. The book is written in a style that is both direct and precise; it manifests the talent of its author who, from a critical and most searching analysis, has succeeded in creating a noteworthy synthesis. ROBERT MATTHEY

The Analysis of Engineering Structures

By Dr. A. J. S. Pippard and Dr. J. F. Baker. Third edition. Pp. xii+564. (London: Edward Arnold (Publishers), Ltd., 1957.) 60s. net.

THE first edition of this useful work appeared more than twenty years ago, and weathered the storms of a second edition to war economy standards. It now appears in its third edition, very largely rearranged and re-written. Some readers may consider it surprising that subjects which have developed rapidly in recent years should have a shorter rather than a longer treatment in the new edition. The authors have, however, written, separately and recently, much more exhaustive treatises on such topics as the design of steel frames, and the plastic theory. Such subjects have, therefore, been given a much briefer treatment here. Classical matter—such as the study of influence lines—is repeated with no alteration but other chapters have been completely re-cast. The work on bow girders, for example, is freshly presented, but a worked example in this chapter tends to give the impression that the evaluation of stresses in non-circular sections in torsion is a routine matter. In the treatment of reinforced concrete and masonry dams—to take only two examples—the authors give space to the determination of stresses, but, somewhat inconsistently, avoid this issue in beams curved in plan. The advance which has been made in soil mechanics is recognized by the provision of a new chapter on earth-retaining structures. This chapter is the result of the collaboration of the authors with Dr. A. W. Bishop, whose reputation in soil mechanics is well established. The new edition is a noteworthy advance on the previous printing and gives readable and authoritative discussions of the more advanced and interesting problems of modern structural analysis. W. F. Cassie

Non-Ferrous Metal Industry in India

A Symposium held at the National Metallurgical Laboratory on February 1, 2, 3, 1954. Edited by Dr. B. R. Nijhawan and Dr. A. B. Chatterjea. Pp. xxvi+297.

Industrial Failure of Engineering Metals and Alloys

A Symposium organized by the National Metallurgical Laboratory, February 5, 6 and 7, 1953. Edited by Dr. B. R. Nijhawan. Pp. viii+347. (Jamshedpur: Council of Scientific and Industrial Research.) n.p.

THAT India has had a non-ferrous metal industry from time immemorial is evidenced by the coins and other metallic articles which exist in such numbers. It was not, however, until comparatively recently that these industries, the iron and steel industry excluded, began to be developed on a modern commercial scale. It is therefore a matter of considerable interest to have this account of the present position attained and of future potentialities. Among the papers which bear on this problem may be mentioned that by P. K. Chatterjee on the non-ferrous mineral resources from the geological point of view, and a survey of the non-ferrous industry in India by B. R. Nijhawan and E. H. Bucknall; taken together these give a very clear general picture of the state of affairs. The great importance of manganese is the justification for the four papers dealing with this metal. India is the second among the manganese-producing countries in the world, and the latest figures indicate the export of more than a million tons of ore per year.

Leaving aside iron and manganese, India's resources of bauxite, magnesite and ilmenite may also be classed as of world importance. Considerable secondary supplies of copper, chromite and vanadium are also available. Lead, zinc, copper, silver, tin, tungsten, nickel, cobalt and mercury are relatively scarce, though it is clear that as a result of the, as yet, inadequate geological exploration of the subcontinent, further discoveries of considerable significance may easily be made. Gold, of which relatively large amounts have been obtained for thousands of years, is found mainly in Mysore, the total output of this metal during 1952 being approximately a quarter of a million ounces.

Coal, though irregularly distributed and mainly found in Bihar and West Bengal, exists in smaller amounts in other localities, and on the supply of this fuel the location of present and future metallurgical plant largely depends.

The symposium on industrial failure consists of twenty-nine papers, all of which bear more or less directly on service failures of engineering parts, the authors being drawn from all parts of the world. A very wide field has been harvested, and although nothing fundamentally new is contained in these papers, they do provide for the design and maintenance engineer the fruits of a large amount of practical experience and some theoretical treatment. From the failure of chilled iron rolls to those due to corrosion, from the photo-elastic methods of stress analysis to failures of machine parts, there are few important sources of trouble to the engineer which are not discussed. F. C. Thompson

Electrical Discharges in Gases

By F. M. Penning. Pp. viii+78. (Eindhoven: N. V. Philips Gloeilampenfabrieken; London: Cleaver-Hume Press, Ltd., 1957.) 15s.

DR. PENNING'S little book is a masterpiece of clear exposition. The collision processes which take place between electrons, positive ions and gas atoms in a weakly ionized gas are discussed in some detail and contrasted with conduction phenomena in metals. After discussing the non-self-sustained type of discharge, including the arc discharge with a thermionic cathode, Penning treats the Townsend-type discharge in which electron emission processes at the cathode electrode play an essential part. The next short chapter is devoted to sparks and lightning. The importance of the space charge effects is pointed out. It is these effects which distinguish the spark discharge from the 'multiple process mechanism' or Townsend-type breakdown.

The last three chapters are devoted to the steady glow and arc discharge. First, the cathode processes and various dark spaces in a glow discharge are discussed, followed, in the last chapter, with a short analysis of the positive column based on Schottky's diffusion theory. Finally, the properties of the high-pressure mercury arc are summarized.

The reader is left with the remarkable impression that electrical gas discharges are, after all, relatively simple to understand. To have achieved this, in so complex a subject, is a tribute to the author's power of expression, and reflects his many and valued contributions. This book is to be commended both to the student and the expert—to the student as an invaluable introduction to the subject, and to the expert as an authoritative survey of the whole field of partially ionized gases. P. C. Thonemann

ROLE OF PLANT HORMONES IN ALGAL METABOLISM AND ECOLOGY

By Dr. JOYCE A. BENTLEY
Marine Laboratory, Aberdeen

THE phytoplankton population of the sea is of great importance in marine ecology. For example, it is estimated that there is a production of 30 thousand million tons of dry matter a year in the sea from the photosynthetic activity of the phytoplankton, and all other life in the open sea is dependent on this activity. Of the phytoplankton the diatoms constitute the most extensive group, yet little is known of the growth requirements of many species, either in their native environment or in culture.

Culturing of marine algae in the laboratory has been developed during the past half-century, and it has been repeatedly shown that in many cases the addition of a natural medium (for example, sea water or soil or algal extracts) to a synthetic medium containing all the known inorganic nutrients is necessary before many organisms will grow. The role of the natural media cannot be solely due to a 'humic acid' effect, as they are still required in cultures where there is an excess of a chelating agent such as ethylenediamine tetraacetic acid in the medium. This suggests that some organic compound or compounds other than the major nutrients necessary for growth is required by the organisms, and leads to the idea that the distribution of these organisms in their native environment may be controlled by these trace substances, at least in part.

Studies by many workers on the subtle ecological relationships of marine organisms have produced results which Lucas[1] has gathered together in support of his theory of non-predatory relationships, based on the release and biological influence of metabolites ranging from "toxins to vitamins and hormones".

Since the algae are plants, it was thought that it might be profitable to investigate the effect of auxins on their growth, and whether they produce these hormones and secrete them to the external medium. Auxins have only been studied critically in the higher plants, yet they affect fundamental aspects of growth, for example, cell elongation and cell division, their primary effect being on the individual cell, and as such are likely to be of importance in the growth of phytoplankton. The role of these substances as transportable hormones in the tissues of higher plants may be superimposed on their original intracellular function.

Work has been in progress along these lines in this Laboratory for the past two years and, although only preliminary as yet, has yielded some interesting results.

To investigate the production of plant hormones by algae, methods of extraction and bio-assay similar to those used to investigate auxins in the higher plants were employed. In order to get enough algal material to yield detectable quantities of auxins, which are likely to occur only in very small amounts, it is necessary to work either with mass cultures or with natural blooms. I am indebted to various workers, indicated later in the text, who have helped me with generous supplies of material.

The algae were extracted usually with either 70 per cent aqueous alcohol or chloroform at *p*H 5·0. The extracts were filtered to remove algal cells, neutralized, the alcohol or chloroform removed under vacuum, and the re-acidified residue extracted with petroleum ether (40°–60°) and then with ether. The petroleum ether fraction was rejected as it contains fatty substances and possibly inhibitors, and the ether extract was separated into acid and neutral fractions. The acid fraction would contain any 3-indolylacetic acid present, and possible precursors such as 3-indolylpyruvic acid.

Recent work on plant hormones has shown that significant biological activity may also be found in the aqueous, ether-insoluble fractions of plant extracts, a fact which is of considerable interest, as the activity cannot be explained in terms of any of the known hormones. It was important, therefore, to examine this fraction; but a direct examination is difficult, because large quantities of pigments, sugars, amino-acids and other substances, all of which interfere with the bio-assays, are in this fraction.

From an analysis of previous work on the aqueous, other-insoluble hormones, it is probable that these substances are unstable auxin complexes, which yield ether-soluble hormones on treatment with acid or alkali[2]. Accordingly, it was decided to autoclave the ether-insoluble fraction with *N* sodium hydroxide and then to look for any ether-soluble acidic hormones produced (saponified fraction).

Suitable quantities of the fractions to be examined were developed on paper chromatograms, usually in ammoniacal *iso*propanol or water, and the papers cut into ten equal fractions along the length of the chromatogram, the fractions eluted and the eluates bio-assayed by the standard *Avena* coleoptile section technique[3], slightly modified to obtain greater sensitivity. Sometimes, colour tests for indole compounds were carried out on the papers.

The following materials have been examined so far: mixed marine phytoplankton, consisting predominantly of diatoms (collected by F.R.S. *Explorer*), pure cultures of *Chlorella pyrenoidosa* (Chlorophyceae), both oven-dried and fresh (from Dr. G. E. Fogg, University College, London), pure culture of *Ochromonas malhamensis* (Chrysophyceae), freeze-dried (from Dr. J. E. Ford, National Institute for Research in Dairying, Reading), *Oscillatoria* spp. (Cyanophyceae) and its medium (from Dr. A. J. Brook, Freshwater Fisheries Laboratories Pitlochry, collected from a persistent bloom occurring as a practically pure culture on a Scottish loch near Blairgowrie, Perthshire), desalted freeze-dried medium from a culture of *Anabaena cylindrica* (Cyanophyceae) (Dr. G. E. Fogg), and filtered sea water from sixty miles off shore (F.R.S. *Explorer*, Scottish Home Department).

Typical results are shown in Fig. 1 in the form of histograms showing biological activity on chromatograms, and positive Ehrlich tests (arrowed lines under the chromatograms). Fig. 1 shows that there is a

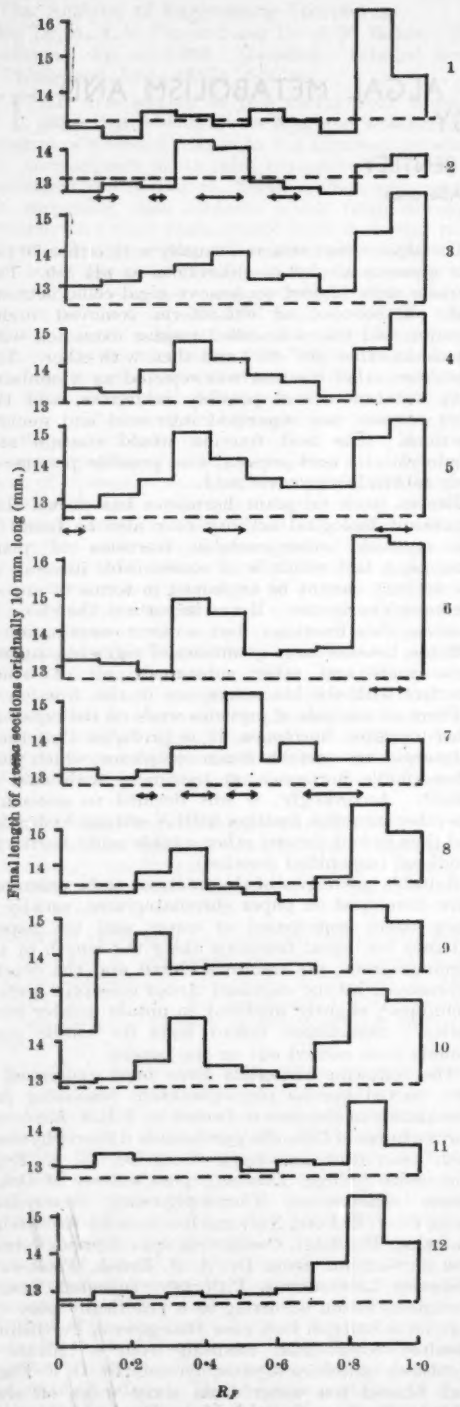

Fig. 1. Histograms of the biological activity of extracts of algae and algal media after chromatography in ammoniacal *iso*propanol. Dotted lines denote water controls. Average R_F 3-indolylacetic acid, 0·35; 3-indolylacetonitrile, 0·85; except in No. 7, where R_F 3-indolylacetic acid, 0·5; 3-indolylacetonitrile, 0·95. 1 and 2, marine phytoplankton acid fraction and saponified fraction; 3, *Chlorella pyrenoidosa* acid methanol-soluble; 4 and 5, *C. pyrenoidosa* acid fraction and saponified fraction; 6 and 7, *Oscillatoria* acid fraction and saponified fraction; 8 and 9, *Anabaena* medium acid fraction and aqueous; 10, filtered sea water acid fraction; 11 and 12, *Ochromonas malhamensis* acid fraction and saponified fraction

zone of considerable activity near the solvent front in the acid fraction of the marine phytoplankton, but no colour reactions could be obtained with the Ehrlich or Salkowski reagents; there is also small but significant activity in the saponified fraction, together with positive Ehrlich tests indicating four indole compounds, one of which corresponds with the centre zone of activity. The same two peaks of activity occur in the acid methanol-soluble fraction of chloroform-extracted dried *Chlorella*, in dried *Chlorella* (saponified fraction) and fresh *Chlorella* (acid fraction).

Indole colour reactions are associated with both peaks of activity in the dried *Chlorella* saponified fraction. The fresh *Chlorella* saponified fraction also contained high activity (not illustrated). Similarly, the same two peaks occur in the acid and saponified fractions of *Oscillatoria*, together with some indole colour reactions, in the medium acid fraction and aqueous non-saponified (first zone displaced nearer the starting line) and filtered sea-water acid fraction of *Anabaena*. There was also activity in the *Oscillatoria* medium (not illustrated). Only one peak occurs in the acid and saponified fractions of *Ochromonas*, not associated with any indole colour reactions. The *Anabaena* medium (aqueous fraction) was desalted and was free from many of the interfering substances present in the other aqueous extracts. It could therefore be examined direct without saponification.

Thus, it is well established that a wide range of algae, covering several classes, contain considerable amounts of biologically active substances with activity similar to the auxins of the higher plants. The two zones of activity, called respectively *X* and *Z* in the remainder of the text, are also found in media in which algae have grown.

The activity in the aqueous and saponified fractions clearly indicates that there are water-soluble, ether-insoluble auxins or auxin precursors of as yet unknown chemical constitution in the algae. These ether-insoluble compounds yield ether-soluble auxins on alkaline treatment. Under the conditions chosen, no ether-soluble auxins are produced from tryptophan. It is possible that the ether-soluble auxins are the same substances as the auxins present in the algae originally (the acid fractions), as both sets show similar behaviour in the following experiments, summarized in Fig. 2. In an attempt to investigate the nature of the activity present in all chromatograms near the solvent front (*Z*), the zone was eluted from papers and re-chromatographed in ammoniacal *iso*propanol. It is quite clear from Fig. 2 that in all cases *Z* splits up on re-chromatography to give a zone which corresponds to the position of *X*, even when, as with *Ochromonas* or the ether-fraction of the phytoplankton, *X* was not originally present. Two peaks of activity were also obtained on re-chromatography of *Z* in water.

Z is possibly an indole compound, but it is clearly not 3-indolylacetonitrile, since it occurs in acid fractions, and it does not give the same colour reactions. Where positive colour reactions have been obtained, *Z* gives a pink or purple Ehrlich reaction, a pink Salkowski reaction and pink nitrite–nitric acid reaction. 3-Indolylacetonitrile gives a purple Ehrlich, blue-purple Salkowski and fading blue

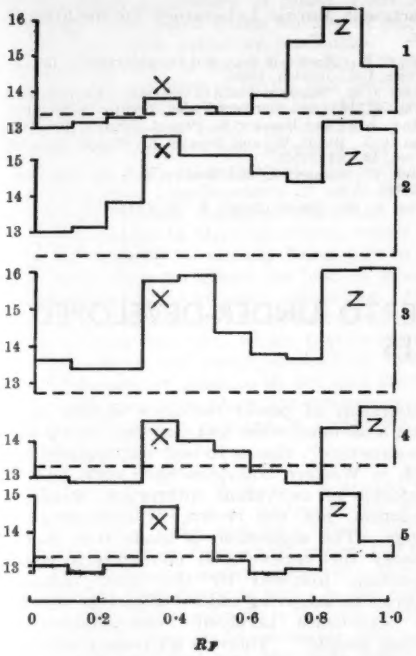

Fig. 2. Zone *Z* eluted from first chromatograms in ammoniacal *iso*propanol and re-chromatographed under the same conditions. Average R_F, 3-indolylacetic acid, 0·36; 3-indolylacetonitrile, 0·85. 1, Marine phytoplankton acid fraction; 2, *Chlorella* saponified fraction; 3, *Oscillatoria* acid fraction; 4, *Ochromonas* acid fraction; 5, *Ochromonas* saponified fraction

nitrite–nitric acid reactions. Further experiments with *Oscillatoria* have shown that *Z* (possibly changed chemically) is still present after boiling with 6 *N* hydrochloric acid and 3 per cent sodium hydroxide, while *X* does not appear from *Z* after this treatment. 3-Indolylacetic acid is produced in easily detectable quantities from its ethyl ester by these treatments, but no activity is produced in the 3-indolylacetic acid region on chromatograms by similar treatments of *Z*. In these respects *Z* resembles the auxin located in extracts of tobacco and shown to be neither the nitrile nor the ester[4].

The same sort of experiment as in Fig. 2 was carried out on *X* in extracts of *Chlorella* and *Oscillatoria*. The results are given in Fig. 3. In both species, *X* gives rise to *Z*. Thus, the two zones show a mutual inter-convertibility, and are therefore probably closely related chemically. Because this

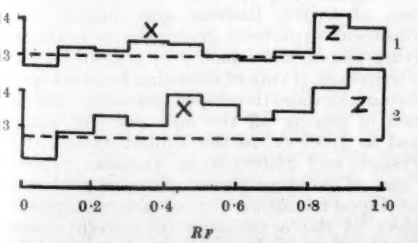

Fig. 3. Zone *X* eluted from first chromatograms and re-chromatographed in the solvents indicated. Average R_F, 3-indolylacetic acid, 0·38; 3-indolylacetonitrile, 0·86. 1, *Chlorella* saponified fraction (ammoniacal *iso*propanol); 2, *Oscillatoria* acid fraction (*n*-butanol : ethanol : 1·5 *N* ammonia : : 6 : 2 : 2)

inter-convertibility is shown in both acid and saponified fractions, *X* in both fractions is possibly the same substance, and similarly *Z*. Both *X* and *Z* may be released to a limited extent from an unstable water-soluble complex by manipulative treatments during the extraction, and so will be found in the acid fraction without any alkaline treatment.

The inter-convertibility of *X* and *Z* may be related to a similar phenomenon observed in extracts of tomato roots, in which three compounds, *X*, *Y* and *Z*, were shown to be mutually inter-convertible[5]. The behaviour of the tomato *X* and *Z* on chromatograms corresponds to the behaviour of the algal *X* and *Z* considered here. If these compounds are indeed identical, it is of great interest that they should occur over such a wide range of the plant kingdom, suggesting that they are concerned with some fundamental aspect of plant cell metabolism. It is obviously very desirable that their chemical constitution should be investigated.

The next step in studies on the role of auxins in algal ecology is to investigate their effect when applied to algae in culture. This has not yet been attempted with the unknown hormones, but a number of papers have been published on the effect of 3-indolylacetic acid on the growth of a variety of species of algae in culture, and several report increases in either cell size or cell number. One or two workers report no effect. There are many difficulties in such an investigation. Rate of entry of the substance at different *p*H values and light intensities has to be balanced against rate of destruction. Taking these various factors into account, probably the most intensive work is that of Algeus[6], who reports that 3-indolylacetic acid definitely affects cell-division in *Chlorella* spp., and *Scenedesmus obliquus*. I have carried out preliminary experiments on the effect of 3-indolylacetic acid on the growth of a marine diatom, *Skeletonema costatum*. I am indebted to Dr. M. Droop, Marine Station, Millport, Scotland, for supplying a bacteria-free culture of this organism, and instructions for culturing.

Skeletonema costatum exists under natural conditions as a long-chain organism, with chains sometimes containing up to 50 or more cells. The bacteria-free culture in a completely synthetic medium consisted largely of single cells, and very few chains more than two or three cells long. This condition persisted in culture through many transfers. An improvement in chain-length was noted on the addition of 3-indolylacetic acid, the average chain-length being about 8 cells at the optimum 3-indolylacetic acid concentrations of 10^{-10} to 10^{-11} gm./c.c. There was also, approximately, a doubling in cell number at optimal concentration (the same order of increase as obtained by Algeus). It should be noted, however, that these effects, even though statistically highly significant, are only small. The optimal chain-length obtained was well below that which could be obtained when the cultures were grown in Erdschreiber medium, which contains soil extract. Chains 50 cells long were common in Erdschreiber. Thus, while some improvement can be obtained on the addition of 3-indolylacetic acid, this is obviously not the only factor lacking in cultures in synthetic media.

To summarize the results reported in this article, it is established that auxin-like substances are produced by a variety of algal cells, and are also present in the media in which algae grow. A synthetic auxin, 3-indolylacetic acid, has a stimulating effect on algal growth, but is not the major natural

auxin produced by algae. This appears to be an unstable water-soluble auxin complex which breaks down to at least two inter-convertible biologically active compounds, which are possibly indole compounds.

The investigations reported in this article are continuing and will be published in detail elsewhere. They have been carried out during the tenure of a Senior Government Research Fellowship, and I am indebted to the Director of the Scottish Home Department Marine Laboratory for facilities for the work.

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POWER DEVELOPMENT IN HITHERTO UNDER-DEVELOPED COUNTRIES

THE eleventh sectional meeting of the World Power Conference, held in Belgrade in June 1957, took as its theme "Power as a Factor of Development in Undeveloped Countries". It is a sign of the awakened interest of these countries in their economic and industrial development that the entire programme of a meeting should be devoted to this subject. The reports, which unfortunately were not generally available in Great Britain for some months after the meeting was held, can conveniently be divided into six sections: (*a*) the economics of power as a factor of development; (*b*) multi-purpose utilization of water courses; (*c*) the use of low-grade fuels; (*d*) nuclear power plants and undeveloped countries; (*e*) power and agriculture; (*f*) power for metallurgical, chemical and allied industries. It is not possible here to do more than indicate the lines of thought and to note items of outstanding interest in the papers, most of which have been published in English, though a considerable number are in French or Russian.

Under the heading of section (*a*) some thirty-eight reports deal with the economic aspects of power and its various ramifications of supply and distribution. There is considerable discussion of what parameter should be adopted to define or to correlate the state of backwardness of an undeveloped country. Power consumption per head would seem to be among the most reasonable. For example, the consumption of power in metric tons of coal per head is 8·18 in the United States, 4·58 in the United Kingdom, 3·14 in Germany and 2·59 in France, whereas it is 0·65 in Yugoslavia, 0·35 in India and 0·27 in Burma. There is a temptation to ascribe backwardness to lack of natural resources, but analysis shows that while the developed countries own only some 50 per cent of the world's coal reserves, 30 per cent of the oil reserves and 25 per cent of the available water-power, they are responsible for more than 70 per cent of the world's output of energy. Whether it is true, as one author suggests, that "this stagnation or low level of production has been brought about by various historical and international causes and under no circumstances has it been a sheer result of lack of natural resources or inertness of the native population" is arguable, bearing in mind Middle Eastern, African and South American experiences; as several other authors state, it seems more likely that backwardness is due to low capital formation.

It is generally agreed by both Eastern and Western authors that power production is so fundamental in the economy of a country that the planning of the development of power resources should be carried out on a national scale, and that the "social economic infra-structure", that is to say, nationalized concerns which in Western countries have been built on the foundation of individual enterprises, should be the foundation, not the crown, of commercial undertakings. The suggestion is made that there is no necessity for undeveloped countries to adopt the programme followed by the older industrialized countries in achieving industrialization, which in the past sometimes involved "immiseration of the working people". There is no reason why old mistakes should not be avoided and industrialization attained much more rapidly by planning on a national or even international scale. Seven of the papers in this section deal with the relation between the consumption of energy and national reserves; Belgium, Japan, Norway, Spain and Sweden are among the countries treated in this way. Various equations are derived for correlating revenue or production with energy consumption.

The policy to be adopted in the development and use of power is fully discussed. One paper points out that a 1 per cent increase of production is likely to require a 2·3 per cent increase of energy, and goes on to show how in Britain it costs more to transmit 1 kWh. of electricity 500 miles than to transport the coal required for equivalent power production 500 miles by rail. It is, however, cheaper to transport the coal 500 miles by water than to transmit the electrical power. Various industries show very different requirements of coal per £1,000 of finished products, the steel industry requiring 90 tons, the motor industry 6·1 tons and the clothing industry 1·7 tons.

Comments in a paper from a Greek source emphasize the importance of designing a power system right from the start so that there is integration of hydro, thermal and nuclear resources. Czechoslovak experience gives priority to the building of hydro-plants, since such projects can be combined with irrigation. Costs of financing large schemes seem to favour the more developed countries; the financial burden of paying off the loan per kW. capacity is quoted as 7,000 fr. in the United States, 10,000 fr. in France, and 25,000 fr. in Tunisia. Presumably the cost of building power plants should be less in undeveloped countries with surplus man-power. The problem of the application of internal combustion engines to local use in areas when the load factor is low is touched on in two papers, one of which suggests that when the load factor is less than 30 per cent it might be more profitable to complete the

network by Diesel generators of about 1,000 kW. capacity; the other paper treats the use of engines of up to 50 h.p. under primitive conditions.

An unusual problem is faced in Iceland. Here, thanks to natural resources of hydro and geothermal energy, at least 300 MW. of electrical energy could be produced surplus to local requirements. This surplus could be exported (to Scotland) by submarine cable, or used to satisfy an aluminium or chemical industry. Development of each scheme requires capital beyond Icelandic resources. The same situation occurs in the Cameroons, where the surplus hydro capacity is already being put to use producing aluminium to relieve the load in France.

Six reports discuss hydro-plant economics. Data are given of the results of the Grand Coulee and North Platte river schemes, where population has increased by twenty- and twenty-seven-fold, respectively, and the value of produce by ten and thirteen times. Russian estimates place the present output of the developing hydro systems of Uzbekistan at 480 MW. from 580 plants.

There are three reports on the economics of nuclear energy. In the first, from Britain, it is argued that at present the development of hydro-electric power is likely to be the most economic when suitable potential exists, but that if the plants exceed 100 MW. capacity, nuclear plants can compete with thermal plants, unless the load factor is low. In the second report, from Italy, the conclusion is that the building of nuclear plant is likely to be profitable only when the cost of imported fuel and the load factor are both high. The third paper, from Japan but dealing with the under-developed portions of the East, suggests that these countries should first build up their consumption of 'conventional' energy until it is high enough to permit the application of nuclear forms.

Among other subjects discussed are the mathematical solution of the economic relationship between hydro-electric and thermal plants in a given system and the most rational installed power capacity of hydro-electric plant for a given flow-duration curve. The problem of meeting loads in excess of the hydro-output—it is generally agreed that steam plants are most economical for supplementing a long-term excess load, but that gas turbines and Diesel engines are preferable for short peak periods—and the division of costs between different consumers in multi-purpose schemes are also examined. Few technical data are provided of actual machinery, but one Russian paper describing the progress in the construction of water turbines in the U.S.S.R. states that Russian industry is now manufacturing a unit of 272,000 h.p. and another of 400,000 h.p. for use on Siberian rivers. A novel suggestion is made for storing compressed air in underground water-bearing strata for eventual use in gas turbines.

In section (*b*) forty-one papers from seventeen countries deal with the multi-purpose utilization of water courses. Most of the papers treat problems in the context of those countries, often highly developed, from which they originate; none the less, the information is valuable for more general use. Any discussion of water resources involves the question of the most economic division of these resources between the conflicting requirements of power production, irrigation, transport and municipal supply. The situation is further complicated by the variation of the available discharge. Most discharges have two maxima and two minima. Waters originating in mountain snow-deposits have higher discharges in summer than in winter, with a winter minimum lower than the summer minimum; for water originating from rains, the converse is usually true. The problem is to tie in these variations with irrigation demands, which are usually greatest in the spring, and power requirements, which are seasonally relatively constant but fluctuate over a daily cycle. Papers describing the situation in southern Italy, where the demands for both irrigation and power are greatly in excess of supply, blame old methods of irrigation which divert water before the points of power utilization, and suggest that storage basins should be erected in streamless valleys. During the night there are certain surpluses of power, so that water could be raised to suitable reservoirs to supply the irrigation networks. The same problems apply to the use of the River L'Oum Er Rbija in Morocco, but here the most important consideration is irrigation. Data are provided of the development of the valley of the Murray River in Australia by swamp reclamation, of the multi-purpose control of the waters of the Missouri, Arkansas, White and Red Rivers in the United States, of the results achieved so far in the Uzbek by the harnessing of the Rivers Sir Darja and Amu Darja flowing into the Aral Sea, of the works on the Dneiper, and on the Kama and Volga, the last two to have an installed capacity of 11,000 MW.

Whereas large developments are proceeding in some countries, others have almost engaged their potential. Japan will shortly have no more water-power to exploit, and will have to turn to thermal and nuclear plant, but hydro-electric plants with storage basins will meet the requirements of peak-load periods. Spain expects to engage all her 9,000 MW. within twenty years. She feels that international exchange of power and possibly even diversion of streams is desirable when rivers flow across national frontiers. Experiments similar to those carried out in Australia have been conducted in Spain on rain-making by seeding clouds over the Pyrenees with silver iodide. The estimated result was 600 million cubic metres of water at a cost of 0·0005 peseta per cubic metre.

Nineteen papers were presented in section (*c*), all from industrialized countries. A world survey suggests that the ratio of high-quality coal to low-grade fuel is decreasing steadily. As high-grade coal fuels are also valuable chemicals as part of metallurgical processes, firing such a fuel merely to produce heat and electricity is the most uneconomic way of using it. Most countries, therefore, are giving much thought to the winning, processing and burning of high ash-content coals, lignites, brown coals, peat and oil shale. New European power plants are now commonly designed to burn such low-grade fuels, which amount to more than 85 per cent of the total European production. In the U.S.S.R., 75 per cent of the electrical power produced thermally is derived from some form of low-grade coal. As world electricity consumption is increasing annually at about 7 per cent (in Europe 12 per cent and in the U.S.S.R. 15 per cent) it is evident that facility in consuming poor fuels efficiently is urgently required.

Lignites (coals with 45–60 per cent water content) can be fired on grates in layers or pulverized in combustion chambers. New installations almost all employ pulverization; the drying process may be carried out during the pulverizing process or separately according to whether a closed or open circuit is used. The pulverizing process may be carried out

in various forms of mills, hammer mills being suitable for lignites of high moisture content. As with lignites, so brown and hard coals, slack and peat can be burned successfully, particularly if pulverized. Peat is especially important in the U.S.S.R., which possesses large reserves and which consumed 50 million tons in 1956. Some of this peat is burned in boilers or chain grates and the rest pulverized by ball mills and dried by heated air burned in cyclone furnaces. No mention is made of peat consumption in gas turbines.

Oil shale occurs in large quantities, often in countries possessing no oil wells. By processing the shale in retorts, about half the organic matter present may be converted to liquid fuel of relatively poor quality. Progress has therefore been made in burning shale directly. In Israel it is coarsely ground in hammer mills and in the U.S.S.R. in ball mills and fired through burners.

Except for a new Czechoslovak two-pass combustion chamber which, it is claimed, will burn all kinds of low-grade fuel of high moisture and mineral content, no new techniques are discussed, but evidently the technology of low-grade fuel combustion is rapidly being mastered.

Section (*d*) dealt with nuclear power plant and undeveloped countries. In the present state of development of nuclear reactors, one of the first requisites for countries lacking experience in their use is to obtain some form of reactor purely as an instrument for training their future technical staff, there being no substitute for practical experience. There is no general agreement yet about the best type of reactor for undeveloped countries, though certain types are obviously unsuitable. Thus, the fast breeder reactor requires too much enriched uranium or plutonium, necessitating high capital expenditure, so that as a small plant this reactor must operate at a very high load factor. A British paper suggests that the aqueous homogeneous reactor, the boiling-water reactor, the organic-moderated reactor and the water-cooled graphite reactor are unsuited by reasons of complication or economy in large under-developed countries, and that countries with large unexploited potentials of fossil fuel in some areas, but with other areas remote from natural fuel supply, would do well to adopt the graphite-moderated, gas-cooled reactor, as has been the policy in the United Kingdom and France. A fuel supply of natural uranium is always likely to be more readily available than enriched uranium. The same paper suggests that small countries should consider the boiling-water reactor or the pressurized-water reactor. Considerable experience has been gained on these and they may be built in packaged units. A paper from the United States also put forward the view that the pressurized-water reactor, as supplied in the *Nautilus*, might be suitable for small countries, and discusses the design of two such plants, one of 11·5 MW. and the other of 143 MW. electrical output. Another American paper supports the use of organic-liquid moderated reactors, using slightly enriched uranium fuel elements. Organic liquids cause little corrosion, do not usually have to be pressurized, have negative temperature coefficients and sustain little induced radioactivity. The major problem is the instability of the organic polyphenyls. Experience is still being gained on a prototype.

After the comments from would-be seller countries, it is interesting to note the Spanish contribution. In Spain it is hoped to begin installation of full-scale plant in 1965, and that by 1970 the installed nuclear power will be 350 MW. Spain possesses sufficient uranium ore to anticipate an annual output of some hundreds of tons. Attention has been focused on those types of reactors on which practical experience has been gained, though in Spanish opinion no experience is as yet very great. The capital cost of Spain's first reactor must be low, and it will be used for training purposes. With these factors in mind, the graphite-moderated reactor is regarded as far too costly, and attention has been directed to the boiling-water and pressurized-water types. As, however, immense pressure vessels cannot be manufactured in Spain, the boiling-water reactor, using heavy water, is likely to be the prototype. When experience has been gained, it is intended that the graphite-moderated reactors will be reconsidered.

There were fifty-five papers in section (*e*), dealing with the effects of power on the social and economic structure of rural communities, methods of producing power, rural electrification, generation and distribution of electricity, internal installations and research on rural electrification.

One effect of electrification on rural social life is often a complete and sudden breakdown of centuries of isolation through the media of television and radio. In the Ardennes, rural electrification has largely checked the flow of population to the towns and has increased milk and vegetable production. The results of electrification in southern Italy are discussed; some idea of the magnitude of the task in India is gained from the fact that 290 million out of 356 million people live in villages, of which only 0·5 per cent are supplied with electricity.

The best use of internal combustion engines of types varying from the long-lasting horizontal single-cylinder oil engine to the open-cycle gas turbine is explained in a British paper, and a Yugoslav contribution compares the costs of electric and internal combustion motors, in favour of the electric motor.

Many papers discuss the increase of productivity with electrification. A good general analysis from world-wide results show that productivity with and without mechanization varies between 3·3:1 and 15:1. Of interest also is the requirement of keeping the cost of generating and distributing power low. Prefabricated concrete elements are used in building hydro-electric plant in the U.S.S.R.; Japan has installed 4,500 small hydro-electric plants of 1,700,000 kW. total capacity. For economy in rural transmission the Russians use steel cable, reinforced concrete posts, the earth as a conductor wherever possible, three-phase nets of high voltage with completely prefabricated transformer stations. In Sweden, experiments are being conducted on the use of polyvinyl cable to reduce the cost of the new installations. India's practice is to use 11-kV. single-phase systems with the earth as a conductor, aluminium–steel or aluminium cables, with wooden or prestressed concrete poles.

Large-scale chemical and metallurgical plant, which play a vital part in the build-up of industry, were considered in section (*f*). Various papers discuss the lay-out of plant components and the recovery of waste heat from the combustion gases, hot air and red-hot products. One suggestion is that the most economical way of recovering waste heat in a metallurgical plant is by the use of a back-pressure gas turbine, a view supported elsewhere. A Russian paper describes the Kuznetzk metallurgical combine,

and shows how a desert region of Western Siberia was transformed in twenty-five years into an industrial centre of 400,000 inhabitants. The site is 400 miles from the nearest large town and endures a winter temperature of − 50° C. About 50 per cent of the electric power of the plant is obtained from waste products. The town is supplied with waste heat and gas from the coking plant. Other industries, for example, a cement factory and a food-processing works, are integrated with the combine.

The question of the best method of using power for metal production attracted some interest. One paper describes the methods of production of the light metals, aluminium, magnesium, titanium and beryllium, both by electrolytic and thermal processes; another, the production of ferro alloys (silicon, chromium, manganese); and a third the economics of producing pig-iron and steel electrically. As a rough rule, it is stated that economic equilibrium is attained between blast and electric furnaces for pig-iron production when the price of 1 kgm. of coal is about five times greater than the price of 1 kWh. of electricity. For countries with a surplus of water-power the electrolytic production of hydrogen is suggested. This can be used as a raw material in nitrogen factories for fertilizer and other chemicals. The electrolysis of water at 30 atmospheres is described as being very efficient and requiring few personnel.

Generally the suggestion is that countries with large resources of power, particularly hydro-power, should encourage the construction of a large integrated metallurgical industry.

The Conference reviewed many aspects of development and much detailed information is published. There is little that is completely new except for the desire of the backward countries, now gradually being realized, to equip themselves with power resources. There was a growing awareness that many problems can only be solved by international co-operation, and that the world is becoming a single economic unit. The day must come when national power systems become international systems and international systems become continental power grids.

F. D. Robinson

OBITUARIES

Dr. G. A. Steven

George Alexander Steven, whose death occurred on April 7 at his home in Yelverton, South Devon, was born at Freswick, Caithness, on April 13, 1901. He was an undergraduate at the University of Edinburgh during 1924–28, being Vans Dunlop Scholar in 1926. He was appointed student probationer at the Plymouth Laboratory of the Marine Biological Association of the United Kingdom in 1928, and joined the permanent staff of the Laboratory in 1929.

Steven, who had practical experience of the sea and fishing in his youth, studied chiefly the biology of commercial fishes, especially the rays and skates and the mackerel. His comprehensive survey of the biology and fishery of the mackerel in the English Channel and its western approaches formed a noteworthy contribution to our knowledge of that species. He also undertook special investigations to assess the possible damage to local fisheries in Devon and Cornwall by seals, and shags and cormorants. In the study of seals he visited all the likely caves on the north coast of Cornwall and made a census of the population.

In 1939 he accepted the post of director of the Newfoundland Fisheries Research Laboratory at St. Johns, in succession to Dr. Harold Thompson. Almost immediately, however, the St. Johns Laboratory was destroyed by fire, and further activities were curtailed by the outbreak of war. After his war service he decided to remain on the staff of the Plymouth Laboratory.

Steven saw service with the Expeditionary Force in France in the First World War, and in the Second World War he served in the Royal Navy. During 1942–45 he was seconded from the Navy to act as fishery development officer of Sierra Leone under the Colonial Office. He was based at Freetown, and under the many difficulties created by the circumstances of war he helped to lay the foundations for post-war fisheries development in West Africa.

His practical knowledge of fishing vessels was put to good use in the assistance he gave in the design and equipment of the Association's research vessel *Sarsia*. His interest in fishing gear led to the writing of a small book entitled "Nets: How to Make, Mend and Preserve Them", which proved very successful. During 1930–40 and 1946–48 he took part in the supervision of the university students' Easter courses at the Plymouth Laboratory. Steven was a D.Sc. of the University of Edinburgh and Fellow of the Royal Society of Edinburgh.

The sympathy of his many friends will go to his widow and two sons.

F. S. Russell

Mr. Frank Kingdon-Ward, O.B.E.

With the passing of Frank Kingdon-Ward on April 8, at the age of seventy-two, the last of the great plant collectors and explorers in the Forrest–Farrar tradition has left the scene. It is now no longer possible for westerners to travel alone for months in the vast areas of Tibet, north Burma and western China, where many of the best of the plants now cultivated in our gardens are to be found in their native habitats. Perhaps the artificial barriers which now block the way will one day be lifted but, in any event, conditions have changed. The aeroplane saves weeks of foot-slogging, and modern medicine provides the prophylaxis to keep the traveller fit. No doubt soon the helicopter will deposit the plant collector on the tops of mountains which it would otherwise have taken months to reach.

Those who are prepared to accept the penalties of one-man exploration—the physical hardship, the utter loneliness of months in a strange land among strange people, the nauseating dullness of a diet of tsampa washed down with rancid butter tea and all the inconvenience of travelling 'light', must possess exceptional courage, determination, loyalty to their sponsors and devotion to their purpose. These qualities, combined with modesty—for all the great explorers were modest men—are qualities which make men great and Kingdon-Ward possessed them in full measure. He was no mere explorer and plant collector. It is true that his contributions to our knowledge of the geography of Tibet, north Burma

and western China were considerable and he made many notable introductions to beautify our gardens. In fact he had done enough in these two fields to have made a name for himself and, indeed, he received many honours from the Royal Geographical Society and the Royal Horticultural Society. He was, however, no mean botanist, plant geographer and plant ecologist, and he wrote much and well on these subjects.

All his expeditions, except the last four, were one-man efforts, and the amount of work he accomplished was outstanding. His specimens were beautifully collected and the notes on them copious. His photography was of a very high standard, and, of course, he was an expert seed-collector.

On his last four expeditions he was accompanied by his wife Jean (*née* Macklin), to whose devotion and care he himself freely admitted the success of these ventures was due. She has the sympathy of all who knew Frank Kingdon-Ward and of the many who know him only through his books and through the objects of beauty, his own introductions, which adorn our gardens. N. L. Bor

Mr. S. B. Smith

Mr. S. B. Smith, who died recently at the age of sixty-six, was associated with some of the earliest engineering developments of Marconi's Wireless Telegraph Co. during forty-four years service until his retirement in 1956. He is probably best known for his investigations into the technique of radio direction-finding, which he started during the First World War and continued in the Company's Research Department which he joined in 1919. He studied the effects of wave polarization on closed-loop aerial systems, and took a leading part in the commercial design and development of the Adcock direction-finder, particularly for use at high radio-frequencies and at long ranges. This resulted in spectacular advances in direction- and position-finding; and the system of greatly improved accuracy found extensive application before and during the Second World War.

Mr. Smith also participated in the development of photo-telegraphy (facsimile transmission); and made a major contribution to the design of the early automatic high-speed commercial services from Chelmsford to European capitals, being largely responsible for the development of the first of such equipments installed by Marconi's in Geneva for the League of Nations.

During the Second World War he was engaged on highly specialized work for the Admiralty and, until he retired in 1956, was consulted by the Armed Services as a leading authority on wave propagation and high-frequency direction-finding. At the time of his retirement he was chief of the Patents Department of Marconi's.

Mr. Smith was for many years a valued member of the Direction-Finding Committee of the Radio Research Board of the Department of Scientific and Industrial Research. He also took an active part in the work of many international committees and conferences convened to discuss the organization of world radio communications. He will be remembered by his contemporaries for his sound judgment in the support of new ideas, and with affection by the many to whom, as young engineers, he extended encouragement and assistance.

NEWS and VIEWS

National Institute for Research in Dairying: Prof. H. D. Kay, C.B.E., F.R.S.

Prof. H. D. Kay, who is to retire in September from the directorship of the National Institute for Research in Dairying, was born in Heaton Chapel, attended the Manchester Grammar School and then the University of Manchester. After military service in the First World War, during which he was awarded the O.B.E. (Military Division), he worked with H. S. Raper in the University of Leeds and then as Beit Memorial Fellow with Harden at the Lister Institute and with Knoop in Freiburg, moving from there to Hopkins's laboratory in Cambridge, where he gained his Ph.D. From a post in the London Hospital, which he held for four years, obtaining in the meantime the degree of D.Sc. from the University of Manchester, he was called to Toronto to a chair of biochemistry. In 1932 he was invited to succeed the late Dr. Stenhouse Williams, first director of the National Institute for Research in Dairying, a post he has held for twenty-six years together with that of research professor in biochemistry in the University of Reading. Under his directorship the scope and size of the Institute have increased markedly, from some twenty research workers in four departments in 1932 to more than five times that number in nine departments and two independent sections at present. His interest in phosphorus compounds, begun in the London Hospital, culminated in the discovery of the phosphatase test for the efficiency of milk pasteurization, which has gained world-wide application. Elected to the Royal Society in 1945, Prof. Kay was made C.B.E. in 1946. To the exacting work of directing a large institute he has added service on many government scientific committees and advisory work for the Food and Agriculture Organization of the United Nations. Hard physical exercise has been his escape from sedentary duties and, a keen gardener, he has for many years been president of the Reading Horticultural Association. A good athlete in his younger days and an intrepid walker at all times, Prof. Kay retires at a youthful sixty-five to take up a special assignment with the Food and Agriculture Organization. He takes with him the wishes of numerous friends for a happy, energetic and industrious retirement.

Royal Agricultural Society of England: Award of Research Medal

The Research Medal of the Royal Agricultural Society of England has been awarded to Dr. W. A. Sexton and Mr. W. G. Templeman.

Dr. W. A. Sexton was co-discoverer, with Mr. W. G. Templeman, in 1940 of hormone and carbamate weed-killers. In 1935 Dr. Sexton joined a section of the Research Department of the Dyestuffs Department, Imperial Chemical Industries, at Brackley, working on the synthesis of products for the control

of insects, plant diseases and weeds, the charge of which he assumed in 1937. In 1941 he was appointed associate research manager in charge of medicinal and pest-control research, his new responsibilities including early work on penicillin. Important discoveries within the Department under his leadership up to 1956 include "Sulphamezathine", "Paludrine", "Antrycide" and "Mysoline". In 1951 Dr. Sexton became a director of the Pharmaceuticals Division of Imperial Chemical Industries, and since 1956 has been responsible for all chemical and biological research in that Division. In 1953 he published a text-book on "Chemical Constitution and Biological Activity".

Mr. W. G. Templeman joined the staff of the Jealott's Hill Agricultural Research Station of Imperial Chemical Industries in 1933 as assistant to G. E. Blackman (now Sibthorpian professor of rural economy, Oxford), whom he succeeded as head of the Botany Section in 1935. More recently, he became associate research manager in charge of the Biological Section and deputy head of the Station. While studying the effects of natural hormones and synthetic analogues on plants and the mechanisms of these effects, Mr. Templeman discovered that naphthylacetic acid killed charlock without harming cereals. Appreciating the practical significance of this, he and his colleagues started an intensive study of the use of synthetic compounds as selective weed-killers. This led to the discovery first of MCPA and then 2,4-D, although work on the latter was proceeding simultaneously at Rothamsted and in the United States. While seeking a chemical which will control monocotyledonous weeds in di-cotyledonous crops as effectively as MCPA and 2,4-D control broad-leaved weeds in monocotyledonous crops, Mr. Templeman found that isopropyl phenyl carbamate is toxic to certain grassy weeds such as couch, providing a good research lead which is being actively followed up.

Beit Memorial Fellowships for Medical Research

Prof. G. F. Marrian has been elected a member of the Advisory Board of the Beit Memorial Fellowships for Medical Research in succession to Dr. C. H. Andrewes, who is retiring after fourteen years membership of the Board.

The following have been elected to Junior Fellowships (worth £900 a year) tenable at the institutions named in brackets: Dr. Phoebe M. Cotes, to study the formation of red blood cells and hæmoglobin in bone marrow cultures from normal and uræmic subjects; and the effects of fractions from normal and uræmic plasma on such cultures (Medical Unit, University College Hospital Medical School, London); Dr. J. G. Nicholls, to investigate the responses of sensory nerve endings in mammalian muscle to stretch and mechanical stimulation, by electrically recording the receptor potential in the nerve endings following stimulation of isolated preparations of muscle (Department of Physiology, University College, Gower Street, London); Dr. G. M. A. Gray, to study the pattern of phospholipids in selected animal tissues with differing biological functions, with the view of correlating this pattern with biological function (Department of Biochemistry, Lister Institute of Preventive Medicine, London); Mr. J. B. Gurdon, to study the developmental potentialities of embryonic somatic nuclei, transplanted into unfertilized egg from which the pronuclei have been removed (Department of Zoology and Comparative Anatomy, University of Oxford); Dr. Margarethe M. A. Holzbauer, to study the adaptive regulation of aldosterone secretion, with special reference to the role of the brain and the pituitary; and the separation and identification of hormones of hypothalamic and posterior pituitary origin (Department of Pharmacology, University of Edinburgh); Dr. F. H. Taylor, to study the dynamic equilibria that exist between unbound and combined lipid components of the erythrocyte membrane; and the relation of the equilibrium states to the structure, breakdown and permeability of the cell wall (Imperial College of Science and Technology, London).

The Orbit of *Sputnik* 3 (Satellite 1958 δ)

From radio measurements made at various places in Britain, the following orbit has been derived for artificial Earth satellite 1958 δ (see *Nature* of May 24, p. 1441), for 10.40 hr. U.T. on May 20:

Inclination of orbit to equator	64·9°	± 0·1°
Nodal period of revolution	105·90	± 0·02 min.
decreasing at about		1 sec./day
Semi-major axis	4001·6	± 0·6 naut. miles
Eccentricity	0·111	± 0·001
Perigee occurs going north at latitude of about		51° N.
Height at latitude 51·2° N. going north	122·5	± 0·8 naut. miles
Rate of rotation of orbital plane (east–west)		2·57 deg./day
Rate of rotation of major axis (retrograde)		0·30 deg./day
Estimated life-time		1¼ years

British Scientific Attaché in Moscow

Mr. H. Nicholls, Parliamentary Secretary, Ministry of Works, in a written reply in the House of Commons on May 22, stated that the Government proposes to appoint a scientific attaché at the British Embassy in Moscow to advise the British Ambassador on scientific matters, and to report on scientific and technical research and development in the Soviet Union.

Committee on Government Research

Replying to a question in the House of Commons on May 21, Mr. Harmar Nicholls, Parliamentary Secretary to the Ministry of Works, said that the Lord President of the Council, in respect of his general responsibility for scientific research, has decided to set up a committee to inquire into the techniques employed by Government departments, and other bodies wholly financed by the Exchequer, for the management and control of research and development carried out by them or on their behalf, and to make recommendations. The membership of the committee is as follows: *Chairman*, Sir Claude Gibb, managing director, C. A. Parsons and Co., Ltd.; Dr. Willis Jackson, director of research, Metropolitan Vickers, Ltd.; Dr. R. P. Linstead, rector of the Imperial College of Science and Technology; Mr. A. A. Part, Under-Secretary to the Ministry of Education; Sir Solly Zuckerman, professor of anatomy, University of Birmingham; Mr. D. Neville-Jones, secretary to the office of the Lord President of the Council.

Society for the Study of Human Biology

Although there are many scientific societies for the furtherance of the biological study of man as an individual, there has been no organization in Britain catering for those (such as physical anthropologists or human geneticists) concerned with human populations. The need for such an association was made

clear at an informal symposium held at the Ciba Foundation in November, when papers were given on "The Scope of Physical Anthropology and Human Population Biology and their place in Academic Studies". Such a society, named "The Society for the Study of Human Biology", was founded on May 7 at a meeting of forty-four people held in the British Museum (Natural History). Its aims are to advance the study of the biology of human populations and of man as a species in all its aspects—particularly human variability, genetics, ecology, adaptability and evolution—by organizing scientific meetings and by attempting to ensure a continuity of workers for long-term research projects in the field. The Society has accepted as founder members all those who, when approached by the steering committee, had agreed to join. The total membership at present is more than a hundred, and those seeking election should obtain nomination from an existing member. The elected members of the committee for 1958–59 are: *Chairman*, Dr. A. C. Stevenson; *Vice-Chairman*, Prof. J. Z. Young; *General Secretary*, Dr. J. S. Weiner; *Programme Secretary*, Dr. G. Ainsworth Harrison; *Treasurer*, Dr. E. Ashton; *Committee Members*, Dr. N. A. Barnicot, Dr. M. J. R. Healy, Dr. A. E. Mourant, Dr. J. R. Napier, Dr. K. P. Oakley and Dr. J. M. Tanner.

British Agricultural History Society: Annual Meeting

The annual meeting of the British Agricultural History Society was held at the Yorkshire Institute of Agriculture during April 10–12. Two papers on Yorkshire farming were read: one by Mrs. Joan Thirsk on the sixteenth century, and the other by Mr. W. Harwood Long on developments thereafter. Mrs. Thirsk's paper was based on the evidence of probate inventories, a source that is being increasingly used. She pointed out that the sixteenth century was a period of rising prices and growing population. Yorkshire farming had at that time a threefold regional character. The Vale was a district of mixed farming similar to that practised in other parts of the country where open-field arable prevailed. The Dales were stock farms, relying upon valley hay as winter feed. Hay houses then, as now, were scattered over the meadows. The Wolds were a region of wild sheep walks with a little corn growing, mainly barley, on small areas near the villages. Mr. Long, using a number of original documents, led his audience over the more familiar ground of Vale enclosure and Wold reclamation to a description of the modern structure of Yorkshire farming. Dr. P. J. Bowden (Sheffield) read a paper on "Sheep Farming and Wool Production in the Sixteenth and Seventeenth Centuries", a subject about which there has been much controversy, especially in relation to the enclosure of arable for sheep. Dr. Bowden relied largely for the details of sheep husbandry on Henry Best's diary of 1641. Dr. S. R. Eyre (Leeds), speaking on the significance of the upward limit of cultivation on the east moor of North Derbyshire, described the physical configuration of the area, and demonstrated how this had affected farming practice in historical times. It was not possible to plough on the steep western escarpment, but on the easier eastern slopes the plough had been used wherever the gradient was less than 1 in 4. The plateau was largely covered with recent peat, formed in the past few hundred years, since for lack of a technique for under-surface drainage the region had remained uncultivated.

The Industrial Film in Technical Education

A conference on "The Industrial Film in Technical Education", organized by the Midland Industrial Film Association, was held on May 8 at the G.K.N. Group Research Laboratory at Wolverhampton. The conference, which aimed at clarifying the needs of the technical teacher, was attended by representatives from nine technical colleges in the Midlands area, the University of Birmingham, the Midland Industrial Film Association and invited speakers. It was under the chairmanship of Dr. T. Emmerson, director of research, G.K.N. Group Research Laboratory. Short papers were read by Mr. Marriott, deputy director of training, Stewarts and Lloyds, Dr. N. A. Dudley, head of the Department of Engineering Production, University of Birmingham, and Dr. H. I. Stonehill, Medway College of Technology, Chatham. A working group consisting of two representatives from technical education and two from the Midland Industrial Film Association was appointed with the following broad terms of reference: to examine and report on the availability of films suitable for use in technical teaching, with particular reference to the needs of the West Midlands area; and to advise on what steps could best be taken to encourage the provision of more films suitable for the purpose in mind, and to advise on the level of audience at which the need is greatest. This group was asked to report its findings to a more widely representative meeting to be held towards the end of this year.

Wear

The new international journal *Wear* has now been appearing for almost a full year. It is published bimonthly under the skilful trilingual editorship of Dr. G. Salomon, of Delft (subscription price: 107*s.* 6*d.*; 15 dollars; 57 Dutch florins per volume comprising six issues (approximately 500 pages). Amsterdam: Elsevier Publishing Co., 1957). The honorary editorial and advisory boards have representatives in America, Australia, Britain, Denmark, France, Germany, India, Italy, Japan, Switzerland and the U.S.S.R., and the official languages of the journal are English, French and German; every article has a summary in two languages. *Wear* is nominally devoted to "fundamentals of friction, lubrication, wear and their control in industry". It is naturally difficult to prevent such a publication becoming narrow and over-specialized and (for a periodical dealing with themes so close to practical affairs) overburdened with technological details. The journal has successfully avoided this tendency, and the articles are of wide interest and of sober scientific value. Two features of particular value are the participation of Russian scientists, and a systematic abstract of current literature at the end of each issue together with details of current international conferences.

Translations of Russian Scientific Literature

Catalogue No. 2 issued by Consultants Bureau, Inc., is devoted to the physical sciences and lists the reports from Russian journals which are available in English translation as separate articles, in addition to more general information about the translation services carried out by the Bureau, including translations of complete journals, books, proceedings of symposia, and a Russian–English physics dictionary. The Catalogue covers physics, metallurgy, electronics, atomic energy, crystallography and physical chem-

istry. The Bureau has also more recently (May 1958) commenced the issue of a monthly guide, *Express Contents*, containing, in English translation, the tables of contents of all Soviet journals being translated and published regularly by the Bureau, other firms and learned societies. The estimated date of publication of the English translation of the particular issue of the journal is given, together with the name and address of the organization from whom the translation may be obtained and the subscription price or individual cost. The first issue of *Express Contents* includes all the January and February material received by the Bureau by March 30, 1958; the June issue will contain March–April material; and the July issue May material. A table of contents of all the 1957 issues of the journals will be published as a single volume in June. In the United States there is a large programme of translation from the Russian, which was the subject of an article by R. E. O'Dette (programme director of the Foreign Science Information Programme of the National Science Foundation, Washington, D.C.) entitled "Russian Translation" in *Science* (125, 579; 1957), where a detailed guide is given to what was being done and planned, and by whom. A more up-to-date statement and, in particular, one relating to the United Kingdom would be most valuable.

Library Science

Under the title "Library Science and Scientific Method", Chapter 8 of the second edition of Dr. S. R. Ranganathan's "The Five Laws of Library Science" has been issued as a separate reprint (pp. ii+355–424. Madras Library Association, 1957). Beginning with a brief discussion of the nature of science and scientific method, Dr. Ranganathan stoutly and skilfully defends his claim for the term 'library science'. Although the difference between science and technology scarcely emerges, Dr. Ranganathan advances ample evidence to justify the consideration of library science as an academic discipline on a par with much that is taught in a university or college of technology. Following further exposition of his five laws of library science, Dr. Ranganathan reviews briefly some of their implications to-day and more especially the opportunities for research in library work, concluding with some account of developments in India and of the Division of Libraries in the United Nations Educational, Scientific and Cultural Organization.

Preparation of Skeletons

In the *Museums Journal* for March 1958, Dr. D. H. Thompsett, prosector of the Museum of Anatomy at the Royal College of Surgeons, describes work he has undertaken in collaboration with Mr. C. G. Bush, articulator. The work is divided into two stages, namely, the preparation of the bones and the articulation of the skeleton. The former stage may be effected either by simmering the bones in water between 60° and 65° C. for a period which varies according to the size of the animal, or soaking the bones in colder water at about 30° C. The skeleton is then disarticulated into six units consisting, respectively, of head, trunk, ribs and pelvis, the two forelimbs, each with half the pectoral girdle, and the two hind limbs. The bones are soaked in a 2 per cent solution of caustic soda to facilitate cleaning and bleached by hydrogen peroxide. Grease stains may be removed by trichlorethylene. In articulation the vertebræ and thoracid cage are dealt with first, and the subsequent stages are fully described. An attractive glossy finish resembling polished ivory can be given to the skeleton by spraying it with transparent synthetic resin.

Fusarium oxysporum as a Soil Saprophyte

The status of *Fusarium oxysporum* Schl.—the pathogen of vascular wilt disease of the oil palm—as a saprophyte in the soil has been examined by D. Park (*Annals of Botany*, N.S., 22, 19; 1958). This fungus was present in soil from wilt-free areas of oil palm plantations as well as in soil about wilt-diseased palms. Hyphal fusions between soil isolates and isolates from wilted palms could be demonstrated. The fungus persisted for periods of at least one year in naturally infested soils under a variety of moisture conditions; it also survived in inoculated alien soils for at least one year. Soil forms of the fungus had a high competitive saprophytic ability, competitively colonizing sterilized soils and sand, and organic materials added to soils and mixed cultures. The pathogenic isolate, as well as the soil isolates, exhibited characters belonging to soil-inhabiting fungi, namely, continued persistence in soil: tolerance, in respect of growth and reproduction, to antagonism: and the ability competitively to colonize dead organic material in soils. The pathogenic form is considered to be a soil inhabitant.

A Transistor Thyratron

An important new device recently made available by the General Electric Company of America is the silicon 'Unijunction' transistor, which is a semiconductor equivalent of the controlled-grid thyratron. It is a three-terminal device, hermetically sealed, with a stable *n*-type negative resistance characteristic over a wide range of temperature. The *n*-type silicon bar is mounted between two ohmic base contacts with a *p*-type emitter near the second base contact. The high peak-current rating makes the device useful in medium power switching and oscillator applications, where it can serve the purpose of two conventional silicon transistors. Some of the applications for which the 'Unijunction' transistor is particularly recommended are sawtooth generators, pulse generators, pulse-rate modulators, pulse amplifiers, multivibrators, flip-flops and time-delay circuits.

Linnean Society of London: Officers

At the anniversary meeting of the Linnean Society of London, held on May 24, the following were elected officers for the session 1958–59: *President*, Dr. C. F. A. Pantin; *Treasurer*, The Earl of Cranbrook; *Secretaries*, Assistant Prof. H. R. Hewer (zoology) and Dr. C. R. Metcalfe (botany). Mr. J. P. M. Brenan, The Earl of Cranbrook, Dr. J. L. Harley, Dr. W. G. Templeman and Dr. H. G. Vevers were elected new members of the Council. Dr. Francisco d'Ascençaõ Mendonça and Prof. Henri Humbert were elected Foreign Members and Mr. Henry Ashley Toombs and Mr. John Clegg were elected Associates *honoris causa*.

Publication of the Carlsberg Laboratory

Since 1934, the *Comptes rendus de Laboratoire Carlsberg* has been published in two series, the *Série chimique* and the *Série physiologique*. In view of the fact that the majority of subscribers receive both series, it has been decided to stop dividing the journal. Thus, Vol. 26 is to be the last of *Série physiologique*, and Vol. 30 will be the last of *Série*

chimique. In future, the journal will continue under its old name, *Comptes rendus des Travaux du Laboratoire Carlsberg*, without designation of series, and its first volume will be Vol. 31. The journal will contain papers originating from both departments of the Laboratory, and affiliated work. Distribution has been taken over by Danish Science Press, Ltd., Torvegade 21, Copenhagen K.

The Night Sky in June

Full moon occurs on June 1d. 20h. 55m. U.T., and new moon on June 17d. 07h. 59m. The following conjunctions with the Moon take place: June 2d. 18h., Saturn 3° S.; June 10d. 16h., Mars 5° S.; June 14d. 03h., Venus 0·8° S.; June 25d. 20h., Jupiter 2° N.; June 29d. 23h., Saturn 3° S. In addition to these conjunctions with the Moon, Jupiter is in conjunction with Spica on June 9d. 15h., Jupiter being 3·7° N., and Jupiter with Spica on June 29d. 18h., Jupiter being 3·6° N. Mercury is too close to the Sun for observation. Venus is a morning star, visible low in the south-east before sunrise, but conditions for observations are not very favourable. It rises at 2h. 30m., 2h. 10m. and 1h. 55m. on June 1, 15 and 30, respectively; its stellar magnitude is about −3·4. During the month its distance from the Earth increases from 102 to 120 million miles and the visible portion of the apparent disk from 0·718 to 0·812. Mars rises at 1h. 30m., 0h. 50m. and 0h. 10m. at the beginning, middle and end of the month, respectively; it is visible in the south-east before sunrise. Its stellar magnitude increases during the month from +0·6 to +0·3, its distance from the Earth decreasing from 117 to 101 million miles. Mars is moving eastwards in Pisces. Jupiter sets at 2h. 10m., 1h. 10m. and 0h. 15m. on June 1, 15 and 30, respectively; it is north of Spica. The stellar magnitude of Jupiter is −1·8, its distance from the Earth on June 15 being 450 million miles. Saturn rises at 20h. 55m., 19h. 55m. and 18h. 45m. at the beginning, middle and end of the month, respectively; it is near θ Ophiuchi, and is visible throughout the night. Opposition occurs on June 13; Saturn is then at a distance of 840 million miles from the Earth and has a stellar magnitude +0·2. There are no occultations of stars brighter than magnitude 6 visible at Greenwich. The summer solstice occurs on June 21d. 22h.

Announcements

Mr. A. T. Welford, lecturer in experimental psychology in the University of Cambridge, has been awarded the H. M. Vernon Prize for 1958 by the National Institute of Industrial Psychology. During 1946–56 Mr. Welford was in charge of the Nuffield Unit for Research into Ageing, Cambridge.

The following new appointments have been made in the Industrial Group of the United Kingdom Atomic Energy Authority: Mr. P. T. Fletcher, formerly director of engineering, to be a deputy managing director; Mr. H. V. Disney, formerly deputy director defence plants, supplies and services, to be a director of engineering; Mr. R. V. Moore, formerly deputy director, civil reactors, to be director of reactor design.

A summer school on "Optical Image Assessment using Frequency Response Techniques", organized by Dr. H. H. Hopkins, will be held at the Imperial College of Science and Technology, London, during July 7–10; a refresher course on elementary Fourier analysis, to be held during June 30–July 1, has also been arranged. Applications to attend either can be made to the Registrar, Imperial College, Prince Consort Road, London, S.W.7, from whom further information can be obtained.

A residential summer course on "The Lunar Society: Science and Thought in the Eighteenth Century", organized jointly by the Departments of Extra-Mural Studies of the Universities of Birmingham and Nottingham, is to be held at Soho House, Soho Avenue, Birmingham, during August 23–31. Soho House, now the property of the General Electric Company (by permission of which the course is to be held there), was once owned by Mathew Boulton, and many Lunar Society meetings took place there. Application forms and further details may be obtained from J. T. Rhodes, Course Secretary, 14–22 Shakespeare Street, Nottingham.

The Scottish Branch of the Road Research Laboratory of the Department of Scientific and Industrial Research at Thorntonhall, near Glasgow, is to hold open days on June 4 and 5. This Branch was established to make research results of the two Divisions of the parent Laboratory (Traffic and Safety at Langley, Buckinghamshire, and Materials and Construction at Harmondsworth, Middlesex) more readily available to those concerned with the construction and maintenance of safe, durable roads in Scotland. It also carries out research on road problems which are especially related to Scottish conditions. Many aspects of the work of the Branch and of the main Laboratory will be on view.

The British Egg Marketing Board will award six postgraduate studentships annually, tenable at universities or other suitable centres in the United Kingdom. The value of each studentship will be £500 per annum (tax free). Studentships will normally be for three years, but it may be advisable to provide for an additional year to be spent on specialized studies overseas. Further information can be obtained from the British Egg Information Service, 1 Dover Street, London, W.1.

The Bureau de Recherches Géologiques, Géophysiques et Minières has decided to publish regularly, and in its entirety, a French translation of the periodical, *Razvedka i Okhrana Nedr* (Prospecting and Protection of Subsoil), the organ of the U.S.S.R. Office of Geology and Protection of Subsoil, published every month. No. 1 (January 1958) was published in May. The subscription is 3,500 fr. a year in France and 4,000 fr. in other countries, or 400 fr. each number in France and 450 fr. in other countries. Further information can be obtained from Service d'Information Géologique du Bureau de Recherches Géologiques, Géophysiques et Minières, 74 rue de la Fédération, Paris (15e).

Errata. In the communication entitled "Action of Acetone on the Tonic Muscle of the Frog", by Dr. A. Zelený and J. Kozák, in *Nature* of May 10, p. 1340, the concentrations of acetylcholine throughout should be in "gm./ml.", not "mgm./l." as printed; the ordinates of Figs. 1 and 2 should read "Contracture". In that entitled "Relationship between Chlorpromazine and Anoxia", by Dr. V. Lindaur, in the same issue (p. 1341), the headings of columns 5 and 6 of Table 1 should be "Standard deviation" and "Σ(deviations from mean)^2", respectively; ref. 4 is to a paper by Raisic *et al.*

JAPANESE INVESTIGATIONS ON NUCLEIC ACIDS

THE Seventh Symposium on Nucleic Acids was held at Nagoya University during February 1–2 under the auspices of the Association for Nucleic Acid Research, which was founded in 1949 and has two hundred members in Japan. The first of the Symposia on Nucleic Acids was held in Tokyo in 1949. At that time, research activities in Japan were greatly hampered by the profound economic and social difficulties of the confused post-war period, and were still in an embryonic state. Papers read before that meeting consisted mainly of review articles of work carried out in other countries. In the following years the Symposia, held at intervals in Tokyo, Kobe and Osaka, helped to stimulate the enthusiasm of Japanese scientists for this very important subject. At the Sixth Symposium (September 1956, Osaka), the meeting for the first time took the form of an international event, four papers being read by scientists from the United States who were visiting Japan.

The latest meeting was honoured by the presence of Dr. Yvonne Khouvine (Institut de Biologie physico-chimique, Paris), who read a paper which summarized the results of metabolic studies on atypical epithelioma, conducted during the past few years in her laboratory, especially in collaboration with Dr. K. Yagi (Department of Biochemistry, Nagoya University Medical School), who also attended the meeting.

In all sessions there were many papers by young workers. Each paper was followed by a discussion, which made the meeting highly informative. Altogether, fifteen papers were read before an audience totalling 60–100 people from different parts of Japan. Some of the important results presented by contributors may be briefly summarized.

By physical and chemical studies of nucleic acids, Y. Kawade (Institute for Virus Research, Kyoto University) and T. Kitamura (Institute of Science and Technology, University of Tokyo) showed that the molecular weight of ribonucleic acid from yeast and liver, prepared by hot dodecyl sulphate extraction, with guanidine hydrochloride, or with phenol, was as high as $1–3 \times 10^5$ and that of tobacco mosaic virus ribonucleic acid (guanidine method) $1–2 \times 10^6$. The configuration of these acids in solution was markedly different from that of deoxyribonucleic acid, and the size and shape of ribonucleic acid depended to a large extent on the ionic strength and other factors. High concentrations of sodium and magnesium chlorides eventually caused precipitation of ribonucleic acid, but this was not the case with deoxyribonucleic acid. Whether these ribonucleic acids are aggregations of smaller units remains uncertain. Two highly interesting papers came from the laboratory of Prof. F. Egami, the present president of the Association. M. Naoi, K. Sato-Asano and F. Egami (Department of Chemistry, Nagoya University) determined the specificity of two ribonucleases (T_1 and T_2) isolated from takadiastase. The specificity of the two enzymes, both resistant to heat, was entirely different from that of pancreatic ribonuclease I. Thus, ribonuclease T_1, with *p*H optimum 7·5, specifically hydrolysed phosphate diester bonds of ribonucleic acid at the 5′-phosphate position of guanylic acid, via 2′,3′-cyclic phosphate; ribonuclease T_2 had its *p*H optimum at 4·5, and specifically attacked adenylic acid 5′-phosphate bonds in ribonucleic acid. Various aspects of the structure of ribonucleic acid and the mode of enzyme action were also presented and discussed. The hydrazinolysis of nucleic acids, leading to the preparation of ribo- and deoxyribo-apyrimidinic acid, was reported by S. Takemura and M. Miyazaki (Department of Chemistry, Nagoya University). Deoxyriboapyrimidinic acid was subjected to the procedure of preparing apurinic acid, yielding polydeoxyribophosphate. These novel compounds were non-dialysable, though the size of the molecule was smaller than that of the original nucleic acids. The importance of this work for the study of nucleic acid structure is evident, and further progress will be rapid.

Physical and chemical studies of ribonucleoprotein particles of rabbit liver cells, reported by M. Takanami (National Institute of Animal Health), revealed the heterogeneity of the so-called microsomes. They consisted of a 250 S. fraction rich in lipids but poor in ribonucleic acid and a 50 S. fraction which was made up of ribonucleoprotein particles with an acid/protein ratio of 2 : 3; this accounted for 45–55 per cent of the cytoplasmic ribonucleic acid. On treatment with deoxycholate the 250 S. fraction liberated a labile ribonucleic acid and another ribonucleoprotein with a sedimentation rate of 50 S. This latter could only be isolated after complete destruction of the 250 S. fraction, and its ribonucleic acid showed a marked difference from that of the 50 S. fraction mentioned above in the rate of uptake of phosphorus-32. Takanami emphasized that the term 'microsome' is a concept associated with the differential centrifugation technique, and may not represent any real structural entity.

On the metabolism and function of ribonucleic acid and ribonucleoprotein, S. Osawa (Biological Institute, Nagoya University) discussed investigations designed to test the hypothesis that a ribonucleic acid extracted from nuclei of animal tissue cells with *p*H 7·1 phosphate buffer might serve as the precursor of microsomal ribonucleoprotein. The findings, including analysis of nucleotide composition, electrophoretic and ultracentrifugal studies as well as tracer experiments, however, were inconclusive. It was then suggested that the incorporation of labelled precursors into microsomal ribonucleic acid was equivalent to that into deoxyribonucleic acid and represented the production of new microsome particles linked to cell proliferation. A very interesting result emerged, however, when he turned to the hypothesis that the *p*H 7·1 ribonucleoprotein of the nucleus, because of its similarity to ribonucleoprotein obtained by the same method from microsomes, might serve as the site of nuclear protein synthesis. Thus, the alanine labelled with carbon-14 was incorporated at an exceedingly high rate into *p*H 7·1 ribonucleoproteins of the nucleus and the microsomes, *in vitro*, and the label was completely separated from the ribonucleoprotein by treatment with streptomycin. K. Miura and I. Watanabe (Institute of Science and Technology, University of Tokyo) reported the nucleotide composition of ribonucleic acid synthesized immediately following phage infection, but before the onset of the synthesis of

phage deoxyribonucleic acid and phage protein, in a *T* phage–*E. coli* complex. The nucleotide composition, estimated from the incorporation of phosphorus-32 into individual nucleotides of ribonucleic acid, was unlike that of normal *E. coli* and was specific to the phage species (T_2 and T_3 were compared). It was not affected by various conditions which prevented phage deoxyribonucleic acid synthesis or the production of progeny phage. But it corresponded fairly well to the nucleotide composition of phage deoxyribonucleic acids, the replacement of the ribonucleic acid pyrimidines for the phage deoxyribonucleic acid pyrimidines being taken into account. Thus, the ribonucleic acid synthesis at an early period of phage infection seems to be under direct control of phage deoxyribonucleic acid. Y. Hotta (Biological Institute, Nagoya University) gave a convincing proof that in the early development of fern gametophytes one-dimensional cell division (leading to the elongation of the plant) and two-dimensional division which followed (leading to the fan-like growth) depended on the amount of protein synthesis. One of the simplest forms of differentiation was thus correlated with the biochemical activity of the cell. 8-Azaguanine, which, like amino-acid analogues, specifically inhibited the two-dimensional cell division, besides being incorporated into ribonucleic acid, produced an appreciable amount of an unknown ultraviolet-absorbing material (probably a nucleotide) in an alkaline digest of ribonucleic acid.

As regards the biosynthesis of deoxyribonucleic acid, T. and R. Okazaki (Biological Institute, Nagoya University) showed that the majority of the acid-soluble deoxyribosidic compounds, found in a deoxyriboside-requiring strain of *Lactobacillus acidophilus* cells, were more than simple nucleosides. The main component was probably a derivative of thymidine diphosphate, and its behaviour under various conditions suggested that it might be an intermediate in deoxyribonucleic acid synthesis. It was also shown that the deoxyribonucleic acid synthesis in the same bacteria can proceed in the absence of ribonucleic acid and protein syntheses and vice versa, while ribonucleic acid synthesis and protein synthesis were inhibited together either by uracil deficiency or by amino-acid deficiency. The inter- as well as intra-molecular homogeneity of deoxyribonucleic acid, with respect to labelling with phosphorus-32, was evidenced by the experiments of Sakaki (Chemical Laboratory of General Education, Nagoya University), using rabbit appendix removed 30 min. after injection with phosphorus-32. The role of pre-existing deoxyribonucleic acid in the incorporation of phosphorus-32 into isolated nuclei of rabbit appendix was discussed by M. Sekiguchi and A. Sibatani (Cytochemistry Laboratory, Yamaguti Medical School). Incorporation into nucleic acid was abolished by treating these nuclei with deoxyribonuclease I but could be restored by adding deoxyribonucleic acid or ribonucleic acid of heterologous origin; even the addition of chondroitin sulphate was effective in restoring the lost activity, suggesting that the effect of added substances was physico-chemical, rather than due to the specificity or the supply of energy-rich nucleotides. The role of deoxyribonucleic acid synthesis in enzyme formation was discussed by N. Otsuji and Y. Takagi (Department of Biology, Faculty of Science, and Department of Biochemistry, Medical School, Osaka University). Intact and 'shocked' protoplasts of *E. coli* strains were capable of forming tryptophanase (by induction) and deoxyribonucleic acid. The presence of 5-bromouracil and 6-azauracil effectively inhibited enzyme formation by preparations of strain *K*-12, while they had no effect when tested with intact cells. With preparations of the thymine-requiring strain 15 T^-, enzyme formation and deoxyribonucleic acid synthesis depended on the presence of thymine. In the absence of thymine only a small amount of enzyme was formed at an early stage.

A limited number of the proceedings of this symposium (in English) can be obtained on request, free of charge, from the Association for Nucleic Acid Research, c/o Prof. T. Suzuki, Department of Pharmacology, University of Kyoto Medical School, Yosida, Kyoto, Japan. A. Sibatani

SALT MARSHES

A SMALL, representative, and successful conference on salt marshes was held at Sapelo Island, Georgia, the Marine Institute of that University, during March 24–29. It was sponsored by the National Science Foundation and the University of Georgia.

There were forty-seven members, including two from Germany, one from Holland, one from New Zealand, and one from Great Britain. All the others were from the United States and Canada. Dr. R. A. Ragotzkie and his colleagues organized both conference and excursions, and all participants are most grateful to them.

The Conference was under the presidency of Dr. A. C. Redfield of Woods Hole, and on each separate day a discussion leader was in charge of the morning session. The first day was devoted to papers on salt marshes as land forms. J. A. Steers acted as chairman and introduced the subject by a paper on the physiography of salt marshes, on both temperate and tropical coasts. L. M. van Straaten followed with an account of the origin of the tidal flats of Holland. R. A. Ragotzkie examined marsh drainage patterns, and were followed by R. J. Russell and J. P. Morgan, who described the morphology of the Louisiana marshes and the coastal changes following hurricane 'Audrey'. In the afternoon there was a field trip to the beach on Sapelo Island, and a few members made a long excursion on the mainland to see the terrace formations characteristic of the coast. In the evening J. Zeigler showed some very pertinent films, taken from the air, of large parts of the Carolina and Georgia coast.

The second day was devoted to a discussion on the vegetation of salt marshes. V. J. Chapman provided a general perspective of the vegetation and showed that maritime salt marshes can be divided into a number of different groups in the different parts of the world. The relationships within a group and between groups can be determined either by analysis of the various floral elements or else by means of affinity coefficients. After E. T. Moul had described the algal flora of salt pans on a marsh the remainder of the morning was devoted to a paper by P. R.

Burkholder on some microbiological aspects of marine productivity in shallow waters. He pointed out that for the annual *Spartina* grass crop only 10 per cent of the dead material remained after being in water for 360 days. This means that mibrobiological decomposition is very active and that on such marshes relatively little organic matter accumulates.

The afternoon was devoted to field trips in groups around Sapelo Island. In the evening W. Hantzchel gave an account of the palæontological significance of molluscan trails and burrows on tidal flats of the North Sea.

On the third day the salt marsh as an eco-system was debated. The discussion was introduced by A. C. Redfield, who gave an account of the movement of heat, salt and water in the soil of Barnstaple Marsh, Mass. Analysis of the salt movements indicated that underlying fresh water was diffusing up and counteracting the downward movement of salt water, though this movement was not sufficient to affect the thermal waves. The next three papers were all concerned with productivity. L. R. Pomeroy gave an account of the diatom flora on Sapelo Island Marshes, A. E. Smalley showed that creekside *Spartina* grass on the Georgia marshes continued to grow after July whereas on the high marsh this was not the case, and J. M. Teal summarized the metabolism of the eco-system in the light of the information available. Although a number of gaps remain to be filled before a final, more accurate, calculation is possible, it seems that about 46 per cent of the energy utilized by the *Spartina* and algæ is transformed and 54 per cent is lost.

The afternoon was devoted to a trip to Blackbeard Island to study the dune ridge system. In the evening A. C. Redfield gave an account of his work on Barnstaple Marsh, Massachussetts.

On the fourth day the use of salt marshes for historical records was discussed. H. M. Raup and F. Johnson gave an account of the archæology and salt marshes of Grassy Island in Massachussetts. E. S. Barghorn demonstrated how the Boylston Street peat at Boston and the peat of the Barnstaple Marsh could be used both archæologically and by radiocarbon dating to measure rate of marsh development in relation to land subsidence. The data indicate a mean subsidence-rate of about 6 in. per century for the past 5,500 years. J. R. Vallentyne discussed some aspects of the biochemistry of mud, particularly in respect of the breakdown of the chlorophyll pigments. The final contribution was by W. Schafer on elements of actuo-palæontology in relation to beaches and shallow seas.

The afternoon was given over to various field trips and one group was flown over the marshes and mainland terraces in the plane belonging to the Woods Hole Oceanographic Institute. This also gave participants an appreciation of just how useful such a plane can be for coastal and oceanographic work. The meeting terminated with a dinner given by Mr. and Mrs. R. J. Reynolds, the owners of Sapelo Island. The University of Georgia is to be congratulated on initiating such a useful conference, which will undoubtedly bear results for a number of years to come.

V. J. Chapman
J. A. Steers

THE CARNEGIE INSTITUTION OF WASHINGTON

REPORT FOR 1956–57

THE Yearbook of the Carnegie Institution of Washington, covering the year July 1, 1956–June 30, 1957*, contains the report of the president and those of Departments and special studies as well as of the Executive Committee and of the auditors. The study of celestial objects as radio sources continued, both at the Mount Wilson and Palomar Observatories, and in the Department of Terrestrial Magnetism, where a programme of flux measurements on a few of the intense radio sources over a wide band of the useful spectrum has become an important project in radio-astronomy. Preliminary scans of the Sun's face made by an antenna array, specially designed for detailed examination of solar radio emission, have revealed localized light sources which move across the disk as the Sun rotates. Further investigation of radio noise from Jupiter indicates that there may be a single centre of activity on the planet with an approximately uniform rotational period, and the construction of a radio-telescope to be equipped with a 60-ft. dish has commenced.

At Mount Wilson spectroscopic observations were carried out with all major telescopes except the 48-in. Schmidt. The photoelectric scanning spectrograph was applied to the study of the energy distribution of the high-velocity giant Arcturus and of two red giants in *M*92. A project on stellar composition and related nuclear processes at Mount Wilson and Palomar Observatories, sponsored by the Physics Division of the United States Air Force Office of Scientific Research, attempts to obtain new astronomical results relevant to theories of the origin of the elements, and to bring together a group of nuclear physicists and astrophysicists interested in aspects of this fundamental question. Photovisual observations of the Cepheids in the outer field of the Andromeda nebula, 96′ south preceding the nucleus, were concluded and also the investigation of the variables in the Draco system. The main effort of the Committee on Image Tubes for Telescopes was directed towards the development of thin-film image converters.

Seismic and gravity studies continue to form an important part of the Department of Terrestrial Magnetism's work, and in co-operation with the United States National Committee for the International Geophysical Year the Department has undertaken a seismic study in the Andean highlands, using as indicators the explosions normally set off in the operation of large open-pit copper mines in southern Peru and northern Chile. Jointly with the Geophysical Laboratory, an investigation was commenced of regional regularities in the ages of the Precambrian rock exposures, which has already indicated that over much of Arizona, New Mexico, Colorado and Wyoming rocks were formed 1,300–1,400 million years ago and some in Ontario 2,600 million years ago. Concordant rubidium–

* Carnegie Institution of Washington. Year Book, 56, July 1, 1956–June 30, 1957. Pp. xi+425+xliii. (Washington, D.C.: Carnegie Institution of Washington, 1957.) 1.50 dollars, cloth bound; 1 dollar, paper bound.

strontium and potassium–argon datings have established an age of about 340 million years for the micas in a number of granitic rock samples collected from the Hercynian chain of western Europe, and it appears that either the Holmes time-scale of the lower Carboniferous, to which these rocks are usually assigned, is not correct or the accepted stratigraphic assignment of the formation requires revision.

Intensive studies at the Geophysical Laboratory of phase-equilibrium relations among the major mineral groups are making available a whole series of geological 'thermometers' which may be applied to igneous and metamorphic rocks, and similar types of 'thermometers' are being developed for ore minerals. In crystallography the Laboratory has demonstrated the first crystalline ultra-phosphate on record and, using an optical analogue, diffraction patterns similar in type to those obtained from X-ray studies of crystals have been produced. Investigations of simple methods of absolute counting of β-radioactivity were continued as well as studies in the production of various basalts, with particular reference to the possibility of obtaining them naturally by differentiation of a parental magma.

In the Geophysical Laboratory work has continued on the synthesis of amino-acids from simpler components under conditions simulating those believed to have obtained on Earth in remote geological periods, and glycine, alanine and serine, as well as more complicated substances, have been obtained by the action of ultra-violet light on an atmosphere of carbon monoxide, nitrogen and lesser amounts of hydrogen, water and carbon dioxide. Other work was concerned with the thermal degradation of amino-acids, while the biophysics group in the Department of Terrestrial Magnetism, concentrating attention on the organization of structure within the cell in terms of some framework larger than a protein molecule, has studied further the amino-acid pools in *Escherichia coli* and in yeast. Evidence was obtained that when the osmotic pressure of the medium is suddenly reduced, a flow of water occurs into the sensitive structures, together with a slow loss of solute from the cell, and that seleno-methionine can completely replace methionine and support exponential growth in a mutant of *E. coli* requiring methionine. It was also demonstrated that, under appropriate conditions, rather large particles containing nucleic acids, proteins and lipids can be made to form 'spontaneously' from disintegrated cellular material, and these particles have been named 'protomorphs'.

In the Department of Plant Biology attempts to isolate the naturally occurring protochlorophyll holochrome were continued, and corn mutants containing chlorophyll, both without and combined with phytol, have been found to form chlorophyll on illumination but to lose it rapidly on further exposure to light. During the year it was shown that large errors can be made in determining the peak position of the absorption bands of pigments occurring at high concentration in living cells, and investigation of the nature of these discrepancies has raised the question whether the double peak of chlorophyll absorption, observed by derivative spectrophotometry, is due to absorption by two actual components, or whether one of these presumed components may be an artefact due to the dependence of light-scattering on wave-length. The study of the growth of algae and their pigment formation in a crossed gradient of light intensity on one axis, and of temperature on the other, continued. Some progress has been made in the study of the comparative physiology of contrasting climatic races of the monkey flower, *Mimulus cardinalis*. Concurrently, genetic investigations and tests of growth responses at the altitudinal stations are being made to determine whether linkages exist between easily recognized morphological characters and the capacity of members of this group to survive at different altitudes. A comprehensive exploratory survey of the comparative growth and physiology of many species and races of Lemnaceae was completed, which disclosed striking differences in growth-rate among genera, species, and sometimes even strains of the same species at the same temperatures and light intensities. Relationships among the various forms of yarrow continued to be studied, and in the *Poa* investigations new results from searching tests involving forty-five apomictic hybrid lines of blue grasses being grown in a wide range of climates in the United States show patterns of performance that can be clearly related to the characteristics of the parental species. The selection of potentially useful agronomic forms of blue grasses has now been narrowed to less than ten.

The investigations of the Department of Embryology are no longer chiefly concerned with the human embryo, and important parts of its work are directed to the study of somatic cell variation in development and the elucidation of the mechanisms regulating differentiation at the chemical level. The report stresses the personal nature of such research. Among the investigations described are those into the metabolic implications of the predominance of retinene$_2$, the aldehyde of vitamin A$_2$ in the tadpole, and of retinene, the aldehyde of vitamin A$_1$, in the adult frog; and the demonstration, in investigations of spontaneous contractability, that in the chick embryo cultivated *in vitro* the addition of a tiny crystal of acetylcholine to the surface of the endoderm results in the formation of two independently beating hearts. Further investigation of the observation that injection into the male guinea pig of testicular extracts combined with adjuvant leads to the destruction of the spermatogenic elements in the testes of the recipient showed that sperm-immobilizing, sperm-agglutinating, and complement-fixing antibodies appear in the sera of the injected animals and not in the sera of animals injected with adjuvant alone. In further studies of the physiology of the placenta, standard procedures were devised for introducing a polyethylene catheter into the amniotic cavity or into the intervillous space or a uterine vein, and results have been obtained showing inherent amplitude–tonus patterns characteristic of individual uteri and of specific developmental periods in animals studied during a single pregnancy. A non-nutrient culture medium for amphibian embryonic tissues, a plastic-sheet method of three-dimensional reconstruction and an aid to the gentle dissociation and re-aggregation of tissue cells are among new techniques described.

The Department of Genetics continued the study of controlling elements in maize, particularly in a system of elements not related to the *Ds–Ac* system that control gene action at two known loci, and also the analysis of a structural modification in maize chromosome 9, one component of which exhibits strikingly aberrant behaviour in both somatic and germinal cells, initiating many different types of change in chromosome organization in somatic cells and inducing an unorthodox type of crossing over in meiotic cells. In analysis of organizational patterns of the hereditary materials in higher plants and animals, in which methods of enzymatic hydrolysis

were combined with modern techniques of electron microscopy, results obtained after deoxyribonuclease treatment of salivary-gland chromosomes of *Drosophila* fixed in osmium tetroxide and stained by the Feulgen method suggest that the main structural fibres are immune to nuclease or acid hydrolysis. New evidence has been obtained that the 'chromosome' of bacteriophage *T2* contains nucleic acid exclusively and that it can multiply in functional form in bacterial cultures containing chloramphenicol. Further work on bacteriophages indicates that reverse mutations restoring the adsorptive capacity occur at the sites of the forward mutations from which they are derived.

Preliminary studies with stocks of the bacterium *Salmonella typhimurium* having various combinations of genetic markers representative of a cystine locus and four tryptophan loci which are so clearly linked that they are carried forward in one transducing fragment have shown that these separate portions of a fragment may be incorporated simultaneously into a newly formed bacterial chromosome. Evidence has been obtained that a transducing fragment is not a randomly selected section of bacterial chromosome, and investigation of the process of haploidization with *Aspergillus* has shown that most haploids arise as a consequence of stepwise loss of one member of the various chromosome pairs. A survey of deoxyribonucleases located a better source of material in salmon testes, and procedures for its extraction and purification are being developed.

EUROPEAN BREWERY CONVENTION TRIALS

THE seventh report of the Barley Committee of the European Brewery Convention deals with the series of field trials carried out in 1956. This co-operative effort, in which thirteen West European countries participated, is the only one of its kind and provides an important precedent for similar work with other crop plants. In the report, comprehensive data collected from the trials are given for each country in which they were conducted. The grain was malted and the relevant analyses are listed. In addition, in Denmark, the malts were subjected to small-scale brewing tests.

It is interesting that grain yields, from the best varieties, were around two tons per acre, at one time considered an exceptionally high yield for the crop. Three varieties, Carlsberg II, Ingrid and Proctor, yielded consistently well in all countries, except for the last in Norway, whereas others, although doing well in some areas, were often poor elsewhere. This adaptability to, and tolerance of, a wide range of environments is an extremely valuable character and appears to come from a single genic source, since these three hybrids, although bred in different countries, Denmark, Sweden and England, respectively, are derived, on one side of their pedigree, from common 'grandparents'. The report mentions that a sub-committee is studying the influence of climate on yield and quality, which should provide useful information on adaptability.

The outstanding feature of a dormancy assessment, made by comparing germinative energy with germinative capacity three weeks after harvest, was that under Norwegian conditions all varieties were extremely dormant except the locally bred Domen. This variety did, in fact, show little or no dormancy in any trial. In no country was the grain quality exceptionally good because the nitrogen contents were high. It is apparent from the malt analyses that the varieties being studied differ from each other within a narrow range of variation. It is also apparent that the high-yield potential of the new varieties has not been obtained at the expense of grain quality; the two characters can be combined in one variety.

The "Descriptions of Barley Varieties" first published by the European Brewery Convention in 1954 is now undergoing revision. A new edition will be issued approximately every five years in order to include new varieties as they come into trial as well as additional information on established ones.

D. H. B. SPARROW

SOCIAL BEHAVIOUR IN THE WILD RABBIT

By K. MYERS and R. MYKYTOWYCZ

Wildlife Survey Section, Commonwealth Scientific and Industrial Research Organization, Albury, New South Wales, and Canberra

UNTIL now, practically all the available information on the social behaviour of the wild rabbit (*Oryctolagus cuniculus* (L.)) has been provided by Southern[1] from his study of a natural warren population near Oxford, carried out during the three years 1939–41. He described the dominance of "certain of the bucks" in the community and their behaviour in relation to their individual "spheres of influence"; he emphasized the "territorial conservatism" of the adult does in particular; and he explained that the social behaviour he observed would encourage polygyny, rather than promiscuity, in a rabbit colony.

As part of its ecological investigations on the rabbit, the Wildlife Survey Section of the Commonwealth Scientific and Industrial Research Organization has developed techniques for maintaining rabbits in enclosures, about 2 acres in area, so that they breed naturally, the individual history and behaviour can be recorded, and activity observed at night as well as during the hours of daylight. Recently, experimental populations were established in enclosures at Canberra and at Albury for studies that were originally unrelated and not primarily intended to be behavioural. These enclosures offered unparalleled opportunities, however, for studying the

behaviour of rabbit communities under conditions closely approaching the natural. Advantage was taken of this, and observations were made independently at the two centres which confirmed and extended Southern's findings. The detailed results of these studies, which are continuing, are appearing in *C.S.I.R.O. Wildlife Research*.

The populations within our enclosures formed communities with a well-developed social structure; and they showed a strong tendency to subdivide into communal groups when numbers increased or were initially high. Membership of a group was well known to all individuals composing it. Each group occupied a well-defined area. Within every community or group a linear hierarchy of dominance became established as a result of trials of strength between individuals, sometimes culminating in fighting. This rigid 'peck' order was demonstrated and maintained by normal dominance relationships between group members. It was always very obvious among males, and was apparent, in the Canberra enclosure, in the females also.

The top-ranking buck possesses the greatest freedom of movement, and ranges throughout the group territory. He monopolizes the females within his group as much as possible. The subordinate bucks, on the other hand, mate only when the attentions of the dominant buck are held elsewhere. The male at the bottom of the peck order is severely restricted in his movements, and rarely has access to a female.

A group's 'territory', like its membership, is well recognized, and it is also generally respected. During the breeding season the adult males are virtually confined to their group territory, and defend its boundaries. A dominant buck becomes subordinate in his relationships with bucks in other groups if he enters their territory. High-ranking females seem to have the same proprietary feeling for the group territory as the bucks, but their more restricted movements give them fewer opportunities to demonstrate it. Subordinate does and younger rabbits are less strictly confined to the group territory, and play no significant part in its defence. The urge to defend the group territory, as such, fades when breeding ceases; but intruders from other groups may be individually resented.

Within the group territory, individual rabbits possess home ranges within which they rest, feed, and reproduce. The home ranges of the different members of the group overlap to a considerable extent. Their boundaries are not defended, and are in fact not precisely defined, as is the boundary of the group territory. The home range is merely a piece of land that the animal knows well, and to which its main daily activities are restricted. In males, the size of the home range depends upon status in the peck order, that of the dominant buck being virtually the same as the group territory.

When breeding is well under way, the does drop their litters at regular monthly intervals. One doe in the Canberra enclosure had seven litters in one breeding season, which lasted for seven months (June–December 1957). This regularity of littering is maintained by the post-partum œstrus, which seems to be of very short duration. For a day or two prior to parturition, the highest ranking among the available bucks shepherds the pregnant doe, guarding her from other males in the group during burrow preparation and nest-building operations. Copulation occurs almost immediately after the emergence of the doe from the breeding burrow, having dropped her litter; thereafter the buck's interest in her wanes.

In both the Canberra and Albury enclosures there has been a remarkable tendency for groups of females to litter simultaneously, that is, within a day or two of each other. The initial synchronization is probably the result of some kind of mutual stimulation. Once it has been established within a group, the mechanism of the post-partum œstrus virtually ensures its maintenance. An important result of the synchronization of reproduction among the adult does in a group is the encouragement of the spread of paternity, by providing more females on œstrus at the same time than the dominant male can monopolize, thus neutralizing to some extent the 'peck-order' effect.

[1] Southern, H. N., *Behaviour*, 1, 3–4 (1948).

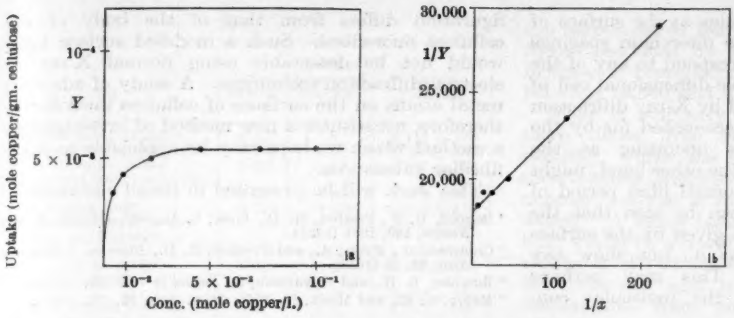
ELECTRON DIFFRACTION STUDY OF ADSORBED METAL IONS ON THE SURFACE OF CELLULOSE MICROFIBRILS

By D. S. BELFORD, A. MYERS and Prof. R. D. PRESTON, F.R.S.
Botany Department, University of Leeds

In a previous communication[1], attention was directed to the existence of a metal–cellulose complex occurring in samples of wood treated with various aqueous salt solutions. When such samples were examined in the electron microscope by means of limited-area electron diffraction, characteristic diagrams were observed. These diffraction diagrams were found to be associated with, and oriented with respect to, cellulose microfibrils. It was evident that a further study of the nature of this complex would be likely to yield new information on the structure of these microfibrils.

Isolated celluloses from a variety of sources were treated with a range of dilute aqueous salt solutions and after washing in distilled water were blended and examined in the electron microscope. Identical patterns were obtained from such diverse specimens as cellulose from the red seaweed, *Rhodymenia palmata*, containing 50 per cent xylose[2] and cotton cellulose when treated with, for example, gold, silver or copper salts.

Intermolecular spacings were calculated using diagrams calibrated individually, obtained from specimens shadowed with aluminium. It was then



Figs. 1*a* and 1*b*. The uptake of copper from copper sulphate solutions by beech α-cellulose

possible to identify all the diagrams obtained in this and in the previous investigation with one of two types, afterwards called Type I and Type II. Every specimen so far examined has yielded both types, the diagrams being superficially similar but differing in their individual spacings.

It was considered desirable to obtain quantitative data on the formation of the complex. The addition of a sample of cellulose to a dilute salt solution is invariably accompanied by a fall in the *p*H of the solution, suggesting that complexing involves the uptake of cations. Cellulose, after treatment with copper sulphate solutions, retains a green coloration, even after thorough washing with distilled water or dilute alkali, but the complex is instantly decomposed by dilute acid. A method of quantitative estimation of 'bound' copper was devised in which the amount of copper removed from the cellulose sample in this way was afterwards determined iodimetrically. Using this method, we have investigated the uptake of copper as a function of concentration, using copper sulphate solutions and beech α-cellulose. The results are represented graphically in Figs. 1*a* and 1*b*, and suggest that the uptake of copper is an adsorption phenomenon in accordance with Langmuir's isotherm.

It should be emphasized, however, that adsorption can take place within cellulose microfibrils, as can be inferred from the results of Roschier[3]. Using pulp samples, he measured the uptake of copper from strongly alkaline solutions; a large uptake is recorded which, under these conditions, continues to conform to Langmuir's adsorption isotherm. In the absence of a swelling agent, however, the adsorption must be largely limited to the outer surfaces of microfibrils. The arrangement of these adsorbed atoms must naturally depend upon the configuration of the surface layer of cellulose molecules.

An adsorbed layer of metal atoms, arranged on the surface of a microfibril in a regular two-dimensional array, will act as a diffraction grating to a beam of electrons, the resultant reflexions being relatively intense due to the high degree of interaction between the electron beam and the atoms. All the electron diffraction diagrams obtained in our investigations may be fully interpreted on the basis of this concept. The Type I pattern (Fig. 2) may be regarded as consisting of two sets of layer lines, reflexions occurring at their intersections as demanded by such a two-dimensional lattice.

The parameters p (along the microfibril length) and q are given by the spacings of the first-order reflexions along the meridian and equator, respectively, the angle φ between them being 90°. From the dimensions of this unit cell theoretical values may be calculated for the positions of the other reflexions. These are in agreement with the measured values obtained from the diagrams. The unit cells for the two types of pattern obtained may be defined provisionally as follows: Type I, $p = 6{\cdot}15$ A., $q = 7{\cdot}05$ A., $\varphi = 90°$; Type II, $p = 7{\cdot}32$ A., $q = 5{\cdot}68$ A., $\varphi = 87°$–$90°$ (variable). In addition, in the Type II diagram reflexions are occasionally noted along the equator, corresponding to a q parameter of 9·80 A. It should be noted that each diagram is given by an aggregation of microfibrils, the length of the arcs in the diagram being a measure of their orientation. From specimens containing randomly arranged microfibrils, for example, *Rhodymenia* α-cellulose, diagrams showing a single orientation are seldom observed. In the case of oriented diagrams, 'hybrids' are occasionally noted consisting of various combinations of patterns I and II.

Such an arrangement of atoms must imply a high degree of order of cellulose molecules at the surface of the microfibril. This conclusion is completely unexpected, when it is considered that all current theories of microfibril structure postulate an outer layer of para-crystalline cellulose. It is further remarkable that all the celluloses so far examined, irrespective of their source and pre-treatment, have given the same types of patterns. With regard to pre-treatment, samples of cellulose of *Pseudotsuga* (Douglas fir) when examined in this way give the same types of patterns before and after mercerization.

Since identical patterns are obtained from celluloses treated with a variety of metal salts, it must be concluded that the spacings of the unit cell relate to the outer layer of cellulose molecules. The q parameters probably give a measure of the distances

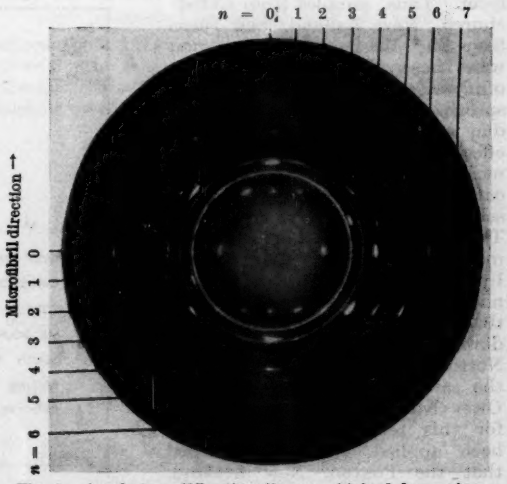


Fig. 2. An electron diffraction diagram obtained from microfibrils of *Pseudotsuga* (Douglas fir) α-cellulose treated with an aqueous 4 per cent ferric sulphate solution. The two sets of intersecting layer lines are indicated diagrammatically

apart of adjacent molecular chains at the surface of the cellulose microfibril. These interchain spacings for the surface layer do not correspond to any of the spacings of the well-known three-dimensional cell of Meyer and Misch[4] as determined by X-ray diffraction analysis, but can probably be accounted for by the differing intermolecular forces operating at the surface. The p parameters, on the other hand, might be expected to relate to the normal fibre period of cellulose of 10·28 A., but it can be seen that the spacings of 7·32 A. and 6·15 A. given by the surface layer of adsorbed metal atoms do not show any obvious direct correlation. This may perhaps indicate that at the surface the molecular configuration differs from that of the body of the cellulose microfibril. Such a modified surface layer would not be detectable using normal X-ray or electron diffraction techniques. A study of adsorbed metal atoms on the surfaces of cellulose microfibrils, therefore, constitutes a new method of investigation, a method which we hope may be applicable to other fibrillar substances.

This work will be presented in detail elsewhere.

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RADIOCARBON DATING OF THE EUSTATIC RISE IN OCEAN-LEVEL

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University Sub-Department of Quaternary Research, Botany School, Cambridge

THE locking up of water in the ice-sheets of the world during the last glaciation is generally agreed to have caused a fall in ocean-level everywhere of the order of magnitude of 100 m. Such a fall, of course, exposed considerable areas of the continental shelf and indeed brought the British Isles into dry-land connexion with the Continental mainland. It is clearly of the utmost importance to biogeographers and archæologists to learn at what time the eustatic restoration of ocean-level after the ice-age occurred, for the extent and timing of this rise controlled the isolation of islands like our own, and thus largely governed the re-population of such islands by migration of animals and plants from the continents.

The development of radiocarbon dating has now placed in our hands the means of securing absolute dating of the submerged peat beds and former strand lines which are the evidence of submergence. For the construction of Fig. 1 we have selected only those records for which well-considered geological evidence indicates (at least approximately) the contemporary height of ocean-level. Thus, samples from Christchurch, New Zealand, and those from the Mississippi delta region were chosen during careful studies of Quaternary geology of the respective regions, and in the latter due regard has been given to the effects of compaction, local tectonic movements and the position of the carbon-dated material in relation to sea-level at the time of deposition. The careful Netherlands datings made at Groningen and reported by de Vries and Barendsen[1] have not been included, since it is clear that they mainly reflect the local down-warping of the southern North Sea basin. In the case of the sample from the Leman and Ower bank, a correction (30 ft.) for this tectonic subsidence has been applied. It is recognized that the Foxton, New Zealand, sample is in a region of tectonic disturbance and that the two samples from the southern Baltic may be somewhat affected by isostatic recovery of the land. The graph gives surprisingly consistent results in view of the world-wide range of sites. It appears to establish that a rapid eustatic rise of ocean-level at the rate of approximately 3·0 ft. per century was in progress between 14,000 and 6,000 years ago. Indication is lacking of the earliest stages and of the full magnitude of the rise, for the maximum extent of which 450 ft. has been suggested[4]. These dates confirm the conclusions reached by Godwin[7,8], Mitchell[9] and others, on the basis of pollen-analyses of coastal peat deposits in the British area, that the eustatic rise was actively in progress during the Boreal period (Zones V and VI—*c.* 9,700–7,500 years ago) and was fully accomplished during the Atlantic period (Zone VIIa—*c.* 7,500–5,000 years ago).

We must expect this tremendous restoration of ocean-level to have been registered by corresponding evidence for diminution in area of the ice-fields of

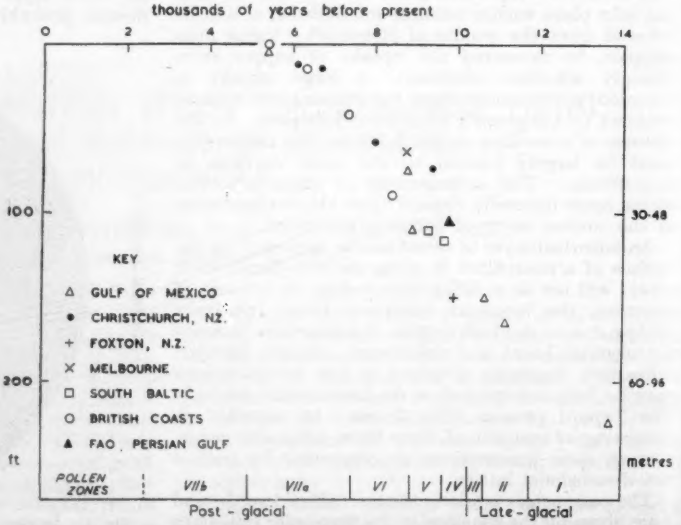

Fig. 1. The eustatic rise of the oceans to their present level, as indicated by samples deposited close to their contemporary ocean-levels. The chronology of the British pollen zones is taken from Godwin, Walker and Willis (ref. 18)

* New Zealand Geological Survey.

Table 1

Site	Carbon dating index	Relation to present sea-level (ft.)	Date : years ago
Tealham Moor, Somerset	Q 120	0	5,412 ± 130
Burnham-on-Sea, Somerset	Q 134	− 15	6,262 ± 130
Poole Harbour, Dorset	Q 181	− 42	7,340 ± 110
Leman and Ower bank (off), Norfolk	Q 105	− 90	8,422 ± 170
Fao, Persian Gulf	Q 278	− 104	9,910 ± 110
Kåseberga, Scania, Sweden	S	− 110	9,331 ± 120
Karlskrona, Blekinge, Sweden	S 120	− 116	9,700 ± 120
Melbourne, Australia	W 95	− 63	8,780 ± 200
Riccarton, Christchurch, N.Z.	N.Z.	− 12	6,100 ± 120
Kaiapoi, Christchurch, N.Z.	N.Z.	− 15	6,700 ± 90
City Centre, Christchurch, N.Z.	N.Z.	− 58	8,000 ± 150
Ellesmere, Christchurch, N.Z.	N.Z.	− 73	9,400 ± 120
Foxton, nr. Wellington, N.Z.	N.Z.	− 150	9,900 ± 150
New Orleans, La., U.S.A.	O 75	c. − 5	5,400 ± 140
Delta Farms, La., U.S.A.	O 73	− 75	8,800 ± 180
Venice, La., U.S.A.	O 86	− 110	8,950 ± 190
Neuces Co., La., U.S.A.	O 45	− 150	10,700 ± 220
Gibson, La., U.S.A.	O 99	− 165	11,200 ± 240
Bayou Pigeon, La., U.S.A.	O 126	− 225	13,650 ± 300

Dating stations for the results shown above are : N.Z., Lower Hutt, New Zealand (refs. 2, 3); O, Humble Oil Co., U.S.A. (ref. 4); Q, Cambridge, England (unpublished); S, Stockholm (ref. 5); W, Washington (ref. 6).

the last glaciation, and it is satisfactory to note that Flint and Rubin[10] have assembled radiocarbon dates which show that between 18,000 and 6,000 years ago the North American ice-sheet withdrew from far south of the Great Lakes to Cochrane, close to Churchill on Hudson Bay. It is also to be noted that the carbon-dated temperature curves for ocean sediments produced by Emiliani[11] show the period of increase in post-glacial warmth to lie approximately between 16,500 and 6,000 years ago.

What is evidently desirable is the collection of more dates from regions of maximum crustal stability, where the sample was formed in closely ascertainable relation to sea-level and where the organic material is unobjectionable for radiocarbon dating. A curve based upon sufficient data of this kind would be a world standard against which values and rates of tectonic and isostatic movements might be measured, and it would afford an invaluable factual base from which to approach problems of biogeography. Our results differ significantly from those reported last year by Shepard and Suess[12], particularly in indicating that the level of the oceans attained that of the present day about 5,500 years ago rather than in the present millennium.

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GAMMA-RADIATION CATALYSIS OF THE OXIDATION BY AIR OF TRI-ISOPROPYL PHOSPHITE

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FROM the infra-red examination of nominally pure samples of tri-*iso*propyl phosphite[1] labelled with phosphorus-32 (200 mc./gm.) it appeared that large amounts of pentavalent phosphorus compounds (indicated by the characteristic P=O absorption) were present. It was afterwards demonstrated that the material was extremely susceptible to air oxidation and also that the P=O absorption was not due to di-*iso*propyl *iso*propylphosphonate formed as a result of an Arbusov rearrangement. Since under similar experimental conditions unlabelled tri-*iso*propyl phosphite is unaffected, it appeared that the oxidation must have been due in some way to the radiation present. A series of exploratory experiments to test this hypothesis are reported here.

The apparatus used for these experiments is shown in Fig. 1. As further supplies of radioactive tri-*iso*propyl phosphite were not available, the experiments were carried out using the unlabelled material in which was suspended a γ source (1 c. of cobalt-60). Air was sucked through the apparatus through a critical orifice so that a constant aeration-rate of 78 ml./min., was maintained. Samples were obtained by creating a sufficient back pressure to force a specimen over into the sampling tube. Analysis of the samples was carried out spectroscopically using a Perkin Elmer Model 21 infra-red spectrophotometer. Determinations of the percentage of phosphate in a sample were made by using the experimentally determined relationship :

$$\text{mole percentage phosphate} = A_1/A_2 \times 56{\cdot}8$$

where A_1 and A_2 are the absorbance at 7·9 microns (P=O) and 9·0 microns (*iso*propyl) respectively. The determination of di-*iso*propyl hydrogen phosphite formed by hydrolysis is not so precise, but estimates

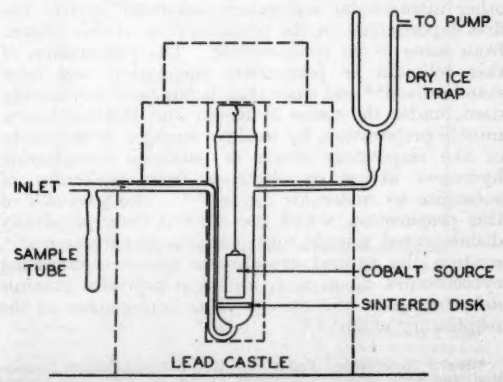

Fig. 1

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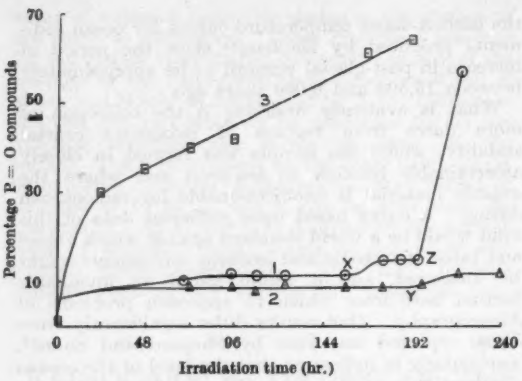

Fig. 2

(c. ± 5 per cent) were made by a comparison of the characteristic P—H stretching vibration at 4·13 microns with the P=O absorption.

The curves showing the rate of conversion of tri-*iso*propyl phosphite to pentavalent phosphorus compounds are given in Fig. 2. The curves 1 and 2, respectively, were obtained from irradiated and control samples of tri-*iso*propyl phosphite which were aerated for 12 hr. per day with air that had been dried by passage through sulphuric acid and then over phosphorus pentoxide.

During the first three days both samples showed slight increases in P=O content but after this point no further change occurred. The control showed some slight signs of hydrolysis suggesting that the reaction had occurred while the apparatus was coming to equilibrium. At points *X* and *Y* on the curve trace amounts of water were deliberately introduced leading to a sudden increase in the P=O content (and hydrolysis) after which the curve flattened again. Further aeration of the irradiated specimen with undried air (*Z*) of 12 per cent relative humidity at 20° C., led to a rapid increase in P=O content from about 10–57 per cent in 12 hr., accompanied by marked hydrolysis.

Curve 3 was obtained by aerating an irradiated specimen with air that had been dried over sulphuric acid. The main feature of the curve is the initial rapid increase in phosphate content followed by a nearly linear increase at the rate of 4 per cent a day (representing 12 hr. aeration), no hydrolysis being detected. It was afterwards shown by freezing out the moisture from air dried with sulphuric acid that the amount of water added during this experiment was equivalent to 2 per cent of the phosphite used.

The results obtained are, in themselves, insufficient to justify postulating a reaction mechanism and the conclusions to be drawn from them are mainly of a negative character. While the effect of radiation on water has been extensively investigated[2] little or no work has been reported on the production of oxidizing species in irradiated, moist air. Presumably a free-radical chain reaction is involved, but it is difficult to postulate a suitable mechanism which is in agreement with all the facts.

Acknowledgments are due to the Defence Research Board of Canada for permission to publish this work, which was carried out under Defence Research Board Project No. *D*52-20-20-20.

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[2] See, for example, *Disc. Farad. Soc.*, 12 (1952).

RECONSTITUTION OF THE SUCCINIC OXIDASE SYSTEM FROM SOLUBLE SUCCINIC DEHYDROGENASE AND A PARTICULATE CYTOCHROME SYSTEM PREPARATION

By Prof. D. KEILIN, F.R.S., and Dr. TSOO E. KING*

Molteno Institute, University of Cambridge

CELL-FREE preparations obtained from heart-muscle have been used since the early stages of the work on the cytochrome system in relation to other intracellular respiratory catalysts[1] and in the first experiments on the reconstitution of this system from some of its components[2]. The preparation of this colloidal or particulate suspension was later standardized[3,4] and since then it has been extensively used, under the name of Keilin and Hartree heart-muscle preparation, by workers engaged in the study of the respiratory chain of catalysts transferring hydrogen atoms or electrons from molecules of substrate to molecular oxygen[5–7]. The particles of this preparation, which are derived from physically disintegrated muscle mitochondria or sarcosomes[8,9], contain the typical cytochrome system comprising cytochromes a_3, *a*, *c*, c_1 and *b*, a powerful succinic dehydrogenase and certain other components of the respiratory chain[1,5–7].

One of the recent advances in the study of the respiratory chain was the isolation by Singer and his co-workers[10,11] of soluble succinic dehydrogenase from heart-muscle sarcosomes. This enabled them to purify the enzyme, which they found to contain one flavine and two or four iron atoms per molecule of enzyme protein of an approximate molecular weight of 200,000. The activity of the enzyme they determined with phenazine methosulphate, which they recognized as an exceptionally suitable hydrogen acceptor since it reacted directly with the enzyme. A series of papers on different aspects of succinic dehydrogenase by Singer and his co-workers, together with the history of previous more or less successful attempts at the isolation of this enzyme, were recently summarized by Singer, Kearney and Massey[12]. Succinic dehydrogenase was independently isolated and purified by Wang, Tsou and Wang[13,14], using for this purpose a heart-muscle preparation deficient[15] in cytochrome *c*, instead of sarcosomes. The nature and the main properties of the purified enzyme were found by them to

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Table 1. Activities of succinic dehydrogenase, succinic oxidase system and cytochrome oxidase system of heart-muscle preparations untreated and treated by 90 min. incubation at *p*H 9·3–9·4 at 18°, 28° and 38° C. followed by neutralization to *p*H 7·4. Activities are determined manometrically at 38° C. in 3·3 ml. 0·1 *M* phosphate buffer per flask and containing for succinic dehydrogenase: succinate (0·037 *M*), cytochrome *c* (1 mgm.) and phenazine methosulphate (2 mgm.); for succinic oxidase system: succinate and cytochrome *c* as above; for the cytochrome oxidase system: cytochrome *c* (1 mgm.), ascorbate (0·016 *M*) and ethylene diamine tetraacetate (8×10^{-4} *M*). Activities are expressed in percentages of those of untreated preparations

No.	Heart-muscle preparation	Succinic dehydrogenase	Succinic oxidase system	Cytochrome oxidase system
1	Untreated	100	100	100
2	Alk. treat. 18° C.	60	13	77
3	Alk. treat. 28° C.	28	< 4	66
4	Alk. treat. 38° C.	0	0	50

agree with those recorded by Singer and his co-workers[13].

The object of the present work was the reconstitution of an active succinic oxidase system from (1) soluble succinic dehydrogenase, (2) soluble cytochrome *c* and (3) the particulate heart-muscle preparation devoid of these two components but having cytochrome oxidase activity.

(1) Soluble succinic dehydrogenase was isolated and purified by the method of Wang, Tsou and Wang[14], slightly modified by us, from an ordinary heart-muscle preparation or one deficient in cytochrome *c*[3,4,15] and brought to the stage of the first ammonium sulphate precipitation. Our main deviation from their method was in the omission of cyanide in the first step of the isolation of this enzyme. The advantage of this method lies in its simplicity; the high concentration and great stability of the enzyme in our heart-muscle preparation renders unnecessary the laborious large-scale isolation of sarcosomes from heart-muscle.

(2) Cytochrome *c* was prepared as previously described[16] from horse heart-muscle. This preparation (0·34 per cent iron) and more purified samples (0·43 per cent iron)[17] obtained from it were equally suitable for this work.

(3) Preparations showing only cytochrome oxidase activity can be obtained[3] by incubating a heart-muscle preparation at *p*H 9·0–9·3; this abolishes the activity of succinic oxidase or of succinic dehydrogenase systems estimated by oxygen uptake or by the reduction of methylene blue, respectively, while the activity of the cytochrome oxidase system is only slightly affected. The direct reaction between succinic dehydrogenase and phenazine methosulphate[10,11] makes it now possible to distinguish the inactivation of this enzyme from the loss of its accessibility to other components of the respiratory chain. This is illustrated by experiments on the effect of incubation of a heart-muscle preparation at *p*H 9·3–9·4, at different temperatures, followed by neutralization to *p*H 7·4, upon the activities of succinic dehydrogenase, the succinic oxidase system and the cytochrome oxidase system.

The results of these experiments summarized in Table 1 show: (1) that the catalytic activities of heart-muscle preparations during alkali treatment decreases with the increase of the temperature (18°, 28° and 38° C.); and (2) that by this treatment succinic dehydrogenase was less inactivated than the succinic oxidase system but more than the cytochrome oxidase system. Although for the reconstitution of the succinic dehydrogenase-cytochrome system the three kinds of heart-muscle preparations treated with alkali (No. 2, 3 and 4, of Table 1) can be used, the experiments summarized below were based upon preparations treated at 38° C. (No. 4) in which the activity of succinic dehydrogenase was completely abolished. This preparation is free of succinic dehydrogenase and of cytochrome *c*, but contains cytochromes a_3, *a*, c_1 and *b*, as well as the antimycin-sensitive factor and probably some other components of the respiratory chain. As the main catalytic property of this preparation can be expressed in terms of cytochrome oxidase activity, it will be referred to as the cytochrome oxidase system, or simply as the cytochrome system preparation.

Soluble succinic dehydrogenase and the alkali-treated heart-muscle preparation tested separately in the presence of sodium succinate and cytochrome *c* showed no oxygen uptake and no reduction of either added exogenous cytochrome *c*, or of the endogenous cytochrome components (a_3, *a*, *b* and c_1) present in the heart-muscle preparation. When soluble succinic dehydrogenase and the cytochrome system preparation were brought together, they formed a very active catalytic system which, in the presence of sodium succinate and cytochrome *c*, showed a vigorous oxygen uptake, and in which all the components of the cytochrome system underwent reversible oxidation and reduction as in an untreated heart-muscle preparation. The activity of the reconstituted system was found to depend both on the concentration of the succinic dehydrogenase and on that of the cytochrome system preparation. Thus, the rate of oxygen uptake in the presence of a definite and constant amount of the heart-muscle preparation treated with alkali rapidly increased with increasing concentrations of succinic dehydrogenase, but the increment fell off when the cytochrome oxidase system approached a state of saturation with the dehydrogenase (see Fig. 1). Similar results were obtained when the activity of the system was determined in the presence of a definite amount of succinic dehydrogenase and increasing amounts of the cytochrome system preparation. In these experiments the soluble succinic dehydrogenase taken up by the particles of the heart-muscle preparation treated with alkali formed an integral part of the respiratory chain. The excess of succinic dehydrogenase added to the muscle preparation took no part

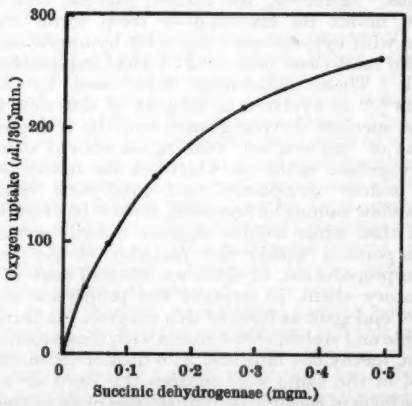

Fig. 1. Oxygen uptake (μl./30 min.) by 3·2 mgm. alkali-treated heart-muscle preparation (see No. 4, Table 1) in presence of 1 mgm. cytochrome *c* (0·34 per cent iron), 0·037 *M* sodium succinate and variable amounts of soluble succinic dehydrogenase in the total volume of 3·3 ml. 0·1 *M* phosphate buffer, *p*H 7·4 per manometric flask

in the catalytic activity of the reconstituted system. The particles of this preparation separated by high-speed centrifugation and washed with buffer solution retained the full activity of the reconstituted succinic oxidase system. The excess of the added succinic dehydrogenase left in the supernatant fluid had only the properties of the soluble dehydrogenase of the same age.

The Q_{O_2} of the reconstituted succinic dehydrogenase-cytochrome system expressed in microlitres of oxygen taken up per hour was 250 per mgm. dry weight of heart-muscle preparation and $3 \cdot 3 \times 10^3$ per mgm. dry weight of added soluble succinic dehydrogenase. The latter value was lower than that recorded[11,12] for the pure succinic dehydrogenase, the Q_{O_2} of which, determined by phenazine methosulphate, is about $1 \cdot 8 \times 10^4$. Our lower value may be ascribed to several factors such as: (1) the succinic dehydrogenase used in our experiments was only 50–60 per cent pure; (2) the Q_{O_2} of succinic dehydrogenase determined by phenazine methosulphate was found to be higher than the Q_{O_2} obtained when succinic dehydrogenase reacted with oxygen *via* the cytochrome system; and (3) no account was taken of the instability of the soluble succinic dehydrogenase. The reconstituted succinic oxidase system was found to be affected by all inhibitors, including antimycin *A*, in the same way and to the same degree as the succinic oxidase system of our standard, untreated heart-muscle preparation.

It is important to note that an active succinic oxidase system has been previously successfully reconstituted by Tissières[13] from two inactive but particulate preparations: one having succinic dehydrogenase, the other cytochrome oxidase activities.

It has been shown by previous workers[12,14], and also observed in the course of the present study, that soluble and purified succinic dehydrogenase differs in several respects from the insoluble, fixed form incorporated within the particles of the heart-muscle preparation. Thus, the great instability of the soluble dehydrogenase contrasts with the remarkable stability of the fixed form. This instability of the enzyme was reflected in the first instance in the loss of its suitability for re-incorporation within the respiratory chain, and only later in the irreversible loss of its activity determined by phenazine methosulphate. Moreover, the soluble succinic dehydrogenase, unlike its insoluble or fixed form, reacts neither with cytochrome *c* nor with hydrogen acceptors like methylene blue or 2 : 6 dichlorophenolindophenol. These differences were used by some workers[10,20] as evidence in support of the view that soluble succinic dehydrogenase may be a degraded enzyme or "an artefact, that is, an altered succinic dehydrogenase molecule which in its native state could reduce indophenol and methylene blue"[20]. Such a view cannot be accepted, since it has now been shown that when soluble succinic dehydrogenase is re-incorporated within the particles of the heart-muscle preparation, to form an integral part of the respiratory chain, it acquires the properties of the fixed or endogenous form of this enzyme. It becomes insoluble and stable, and it reacts with the cytochrome system, methylene blue and 2 : 6 dichlorophenolindophenol in the same way as does the fixed or endogenous form of succinic dehydrogenase of an untreated heart-muscle preparation. This also confirms the previous observation[21] on an intact heart-muscle preparation showing that the reductions of methylene blue and of 2 : 6 dichlorophenolindophenol are brought about not by succinic dehydrogenase alone but by a system of which this enzyme and cytochrome *b* are two of the components so far known.

The changes in the properties of the soluble succinic dehydrogenase are due, not to its mere contact with the particles of the heart-muscle preparation, but to its re-incorporation within the respiratory chain of these particles. It is conceivable that the soluble dehydrogenase re-occupies the original sites left free by the endogenous dehydrogenase displaced by alkali treatment of the heart-muscle preparation. In fact, this treatment causes the displacement of endogenous dehydrogenase, reflected in the loss of its accessibility to other components of the respiratory chain, before causing the irreversible inactivation of this enzyme, as shown by its inactivity towards phenazine methosulphate (Table 1).

The relationship between soluble (exogenous) and fixed (endogenous) forms of succinic dehydrogenase is analogous to the relationship between exogenous and endogenous cytochrome *c*. The fact that these two forms of cytochrome *c* differ in their catalytic activity, in their reactivity towards cyanide and even in the position of their absorption bands[22] suggested the possibility that on isolation and purification cytochrome *c* undergoes some changes in its structure and properties. That this is not so was demonstrated by Tsou[15], who found that soluble cytochrome *c* re-incorporated within the heart-muscle preparation re-acquires all the properties of the endogenous component[15,22]. It is possible that similar observations will be made on other components of the respiratory chain when they are successfully isolated and purified.

This investigation has shown that an active succinic oxidase system can be reconstituted from soluble succinic dehydrogenase, soluble cytochrome *c* and the particulate heart-muscle preparation devoid of these components but having cytochrome oxidase activity. In a reconstituted system, the soluble succinic dehydrogenase is incorporated within the particles of the preparation to form an integral part of the respiratory chain involved in the oxidation of succinic acid. The re-incorporated enzyme re-acquires all the properties of the fixed, endogenous succinic dehydrogenase of a standard Keilin and Hartree heart-muscle preparation.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Accumulation of Radioactive Fall-out by Plants in the English Lake District

THIS communication reports an exploratory study of radioactivity in natural and cultivated vegetation. Thirty-five species of angiosperms and mosses, representative of a wide range of non-calcareous woodland, bog and fen habitats, were collected, and twenty samples of roots and tops from seven species of cultivated vegetables, near Windermere during early 1958. For a wider view, nineteen collections of the bog moss *Sphagnum papillosum* were made in various parts of the Lake District, and two near Garrigill and Malham in the Pennines. In addition, eleven stream and lake waters were analysed. Twenty-seven herbarium specimens of wild plants collected in the decade prior to 1947 were also examined. Their activity, due to long-lived natural isotopes, can be taken as little lower than when collected.

The plants were dried at 105–110° C. and ashed at bright red heat; the waters were evaporated with nitric acid before ashing. Aliquots of about 50 mgm. ash were fixed in planchets with 'Celloidin' and tested within three days of collection for radioactivity, in a lead tower with a *CV* 2139 counter tube (end-window weight, 2·3 mgm./cm.²). At least 1,000 counts were recorded for each sample on a 'Panax 44*A*' scaler. Background counts, averaging 8 per min., were measured daily and subtracted from those shown in Fig. 1. No correction for self-absorption was applied, nor were the isotopes involved identified. The results merely give an arbitrary comparison of total activity in different plants.

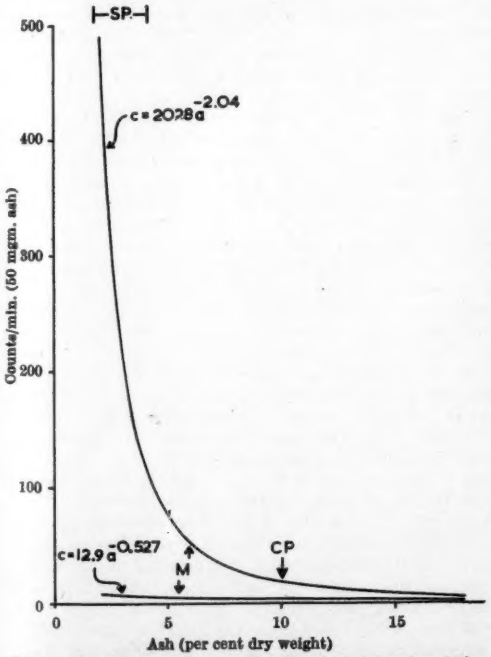

Fig. 1. The relation between radioactivity of plant ash and the ash content of the species. The upper curve represents samples taken in 1958; the lower, herbarium specimens collected prior to 1947. *M* shows the general log means, *CP* the mean ash content of cultivated vegetables, and *SP* the range of ash in *Sphagnum papillosum*. In the equations *c* represents counts per min. and *a* ash percentage

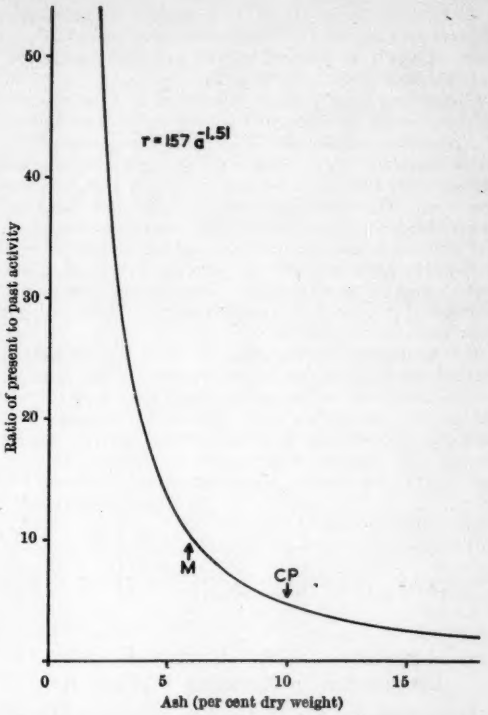

Fig. 2. Ratio of present to past radioactivity in plants of different ash content. In the equation *r* represents ratio and *a* ash percentage

The count-rates of plant ashes were closely related to the mineral content of the species. The correlation coefficients (*r*) for logarithms of the rate of counting and percentage ash were −0·82 for the species collected in 1958 and −0·66 for the herbarium specimens. The logarithmic regressions of rate of counting upon percentage ash are shown arithmetically in Fig. 1, and it is clear that plants of low ash content now exhibit very much more radioactivity than those with a large mineral intake. This is true whether activity is calculated per unit of ash or of dry matter, and is to be expected since the plants with low ash generally grew on the more acid soils, where radioactive fall-out must account for a greater proportion of the soluble or adsorbed elements available to the vegetation. The cultivated plants, growing on the better soils, averaged 10 per cent ash as against a general mean of 6 per cent.

It is of interest to compare present count-rates with those prior to the nuclear era, and this has been done in Fig. 2, where the ratio of present to past activity is plotted against percentage ash. Evidently the activity of plants low in ash has increased up to fifty-fold over the past decade. The increase averages ten-fold for all plants, and declines to as little as two-fold in plants of high ash content on the best soils.

As an estimate of ability to accumulate radioactive materials, the ratio of count-rates of plant ash to those of ash from natural waters has been calculated. The concentration factor is 23.

Concerning geographical distribution of fall-out, no pattern could be discerned in the rates of counting of *Sphagnum papillosum* from different parts of the Lake District and Pennines, though the typical decline with increasing ash (range shown in Fig. 1) was observed. The Windscale accident therefore appears to have contributed little to the activity measured. The decline in the rate of counting recorded for three *Sphagnum* samples over one month averaged about one-quarter of the original. Presumably the radioactivity of present vegetation is largely due to fall-out from nuclear explosions.

The biological significance of these results lies in the indication that plants which have a low mineral intake and grow on extremely acid soils accumulate radioactive fall-out to an extraordinary degree. The high concentration of strontium-90 in bones of upland sheep[1] may well be due in part to their reliance on such plants for fodder, especially in hard times.

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Detection of Single Quanta of Circulation in Rotating Helium II

By measuring the hydrodynamic circulation around a fine wire placed in rotating helium II, direct experimental evidence has been obtained both for the quantization of this circulation and for the peculiar flow pattern to be expected in the superfluid component of uniformly rotating helium[1,2].

The apparatus consists essentially of a brass tube (internal diameter, $2b$, 5 mm.) down the centre of which is stretched a fine beryllium–copper wire (diameter, $2a$, 0·001 in.; 5 cm. long). The tube can be placed in a cryostat and filled with liquid helium, and the whole tube assembly can be rotated about an axis coincident with the wire. A transverse magnetic field can be applied to the system, so that transverse vibrations of the wire can be generated by passing a current (pulsed or alternating) through the wire, and observed as a voltage induced between the ends of the wire.

A curl-free circulation of liquid around the wire can then be measured by studying these vibrations. If there is no circulation, each mode is really doubly degenerate owing to the possibility of vibration in two directions at right angles. However, if there is a circulation $\varkappa$, this degeneracy is removed through the action of the Magnus effect, the normal modes become two circularly polarized modes with opposite directions of rotation, and these modes are split by a frequency-difference $\rho_s\varkappa/2\pi w$, where w is the mass per unit length of the wire. In practice, this splitting is obtained as the frequency of beats superimposed on freely decaying oscillations of small amplitude generated by discharging a condenser through the wire. At the frequency used (~ 500 c./s.), the Q of the vibrating wire, which is limited by the viscosity of the normal fluid, proves to be just large enough to allow the measurement of a circulation of order h/m to within 2–3 per cent, provided the temperature is less than about 1·4° K.

The experimental procedure consists in first bringing helium I into rotation with the apparatus at a steady angular velocity ω, then cooling the liquid slowly through the λ-point to 1·3° K. while it is still rotating, and finally stopping the rotation. It is reasonable to suppose that the superfluid will form in a state corresponding to the effective ground-state of the liquid in the rotating vessel (that is, the state for which the quantity $(F - M\omega)$ is least, where F is the free energy of the system and M its angular momentum); if the ideas of references (1) and (2) are correct, this state will be as follows: (i) for $\omega < \omega_0 = \frac{h}{m}(\ln b/a)/(b^2 - a^2)$, superfluid at rest; (ii) for $\omega_0 < \omega < \sim 3\omega_0$, one quantum, h/m, of curl-free circulation around the wire; (iii) for $\omega > \sim 3\omega_0$, one or more quanta of circulation around the wire, with the possible addition of an array of free vortex lines in the helium between the wire and the tube; the precise arrangements to be expected depend on the energy of a free vortex line (that is, on the magnitude of its effective core radius a_0).

It is also reasonable to suppose that when the rotation is stopped, any circulation around the wire will persist for a considerable time. The aim of the experiment is to use measurements of the circulation around the wire to check these predictions and provide a value of the core radius a_0.

The experimental results show that cooling the rotating system from above the λ-point does give rise to circulations of order h/m around the wire for angular velocities greater than approximately ω_0 (about 7·5 rev./hr.), and that these circulations will usually persist unchanged for periods as long as an hour after the rotation is stopped. However, the *apparent* circulation is rarely equal to an integral multiple of h/m. It is clear that this behaviour could be associated either with an absence of quantization or with the fact that a quantum of circulation could surround a certain length of wire and then become detached as a free vortex line. Evidence that the latter is the case, and that circulation is really quantized, is provided by the observation that, after the rotation is stopped, the apparent circulation can always be reduced by vibrating the wire with a very large amplitude, but that often it can be reduced only as far as a value that is equal, within the experimental error, to exactly h/m. This behaviour is consistent with the plausible idea that large-amplitude vibrations of the wire can remove a vortex line that is only partly attached to the wire, but not one that is wholly attached.

A complete set of experimental results for circulation in the rotating system as a function of angular velocity is not yet available, but it may be remarked that the results obtained so far suggest that the effective core radius of a free vortex line may be as large as 10^{-5} cm. This may be compared with the value of order 10^{-8} cm. suggested by Feynman[2] and the value 3×10^{-7} cm. obtained by Hall[3] from observations of the velocity of waves on vortex lines. A proper quantum mechanical description of a vortex line might provide an explanation of these discrepancies, for such a description might show that the simple picture of a vortex line used by Feynman is inadequate, and might also show either that the effective core radius which governs the vortex/wave velocity differs from that which governs the energy per unit length, or that the effective core radius varies with the experimental conditions.

Preliminary work on this experiment was reported at the 1957 Low Temperature Physics Conference at Madison[4], but at that time it had not been successful.

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May 4.

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Theoretical Analysis of Doppler Radio Signals from Earth Satellites

THIS communication describes very briefly a method of determining the orbit of an artificial satellite from measurements of the Doppler shift of its radio signals.

Theoretically, with perfect instrumentation and no atmosphere, each possible ballistic orbit of an Earth satellite produces a unique dependence upon time of the Doppler frequency shift. Thus in principle any finite time sample of such a Doppler curve will yield a unique orbit. The experimental accuracy to which frequency and time can be measured leads one to believe, *a priori*, that in the absence of serious refractive effects one can reasonably expect to obtain accurate orbits through an analysis of the observed Doppler shift of the radio signal of an Earth satellite as a function of time.

The theoretical expression for the Doppler shift, neglecting relativistic corrections, is given by

$$\Delta f(t) = \frac{f_0}{c}\frac{d\Lambda(t)}{dt} \qquad (1)$$

where f_0 is frequency of the satellite transmitter, c is velocity of light, Λ is optical path-length of radio signal ($= \int_P n ds$), n is index of refraction.

Applying Fermat's principle and assuming that n is a function of altitude only, it can be shown that:

$$\Lambda(t) = \int_{r_E}^{r_s(t)} dr \frac{rn^2(r)}{\sqrt{\{r^2n^2(r) - r_E^2 \sin^2\beta(t)\}}}$$

$$\chi(t) = \sin\beta(t) \int_{r_E}^{r_s(t)} \frac{dr}{r} \frac{1}{\sqrt{\{r^2n^2(r) - r_E^2 \sin^2\beta(t)\}}} \qquad (2)$$

where r_E is radius of the Earth; r_s is distance of satellite from the centre of the Earth; $\chi(t)$ is angle between satellite and observing station measured at the centre of the Earth; $\beta(t)$ is angle of arrival of radio waves measured from zenith. Solving equations 2 to eliminate the angle $\beta(t)$, constraining $r_s(t)$ to obey the known elliptical motion of the satellite, and then substituting the resulting expression for $\Lambda(t)$ into equation 1, an expression for the Doppler shift is obtained in which the only function not completely determined is the index of refraction, $n(r)$.

The procedure that has been adopted by us in applying this analysis is to assume a functional form for $n(r)$ which contains one adjustable parameter. The theoretical expression (equation 1 plus equations 2 with the proper constraints) is then used to compute a Doppler shift which is compared with experimental results. By adjusting the six parameters describing the orbit, the refraction parameter and one additional parameter describing the transmitter frequency of the satellite, the computed $\Delta f(t)$ is brought into a least-squares fit with the experimental $\Delta f(t)$. A 'Univac Scientific 1103*AF*" digital computer was used for the rather complicated numerical calculations.

The results of applying the above analysis to actual orbit determinations are listed in Tables 1 and 2. The results were obtained by 'beating' a stable local oscillator with the signal from the satellite and recording the resulting audio signal on tape simultaneously with standard time markers from station *WWV*. This tape was then played back through a wave analyser (with a pass band of ~2 c./s.) to obtain $\Delta f(t)$.

Table 1. SPUTNIK I: 20 Mc./s.

Estimated experimental error	± 4 c./s.
Root-mean-square fit to observations	± 1·6 c./s.
Approximate ground-range	73 stat. miles
Minimum angle of arrival from horizon	20°
t_0 = 2347 G.C.T., October 21, 1957	
Latitude of *O*	38° 41′ N.
Longitude of *O*	75° 59′ W.

Orbit element	Doppler determination	Ref. 1*	Ref. 2†
Period	95 min. 38 sec.	95 min. 36 sec.	95 min. 34 sec.
Eccentricity	0·053	0·053 ± 0·001	0·048 ± 0·002
Inclination	64° 10′	64° 40′ ± 10′	65°
Arg. of perigee	43° 30′	—	—
Latitude of perigee	38° 20′ N.	36° ± 3° N.	40·9° N.
Longitude of asc. node	289°	291·6° ± 0·3°	—

* Staff of the Mullard Radio Astronomy Observatory, Cambridge, *Nature*, **180**, 879 (1957).
† Staff of the Royal Aircraft Establishment, Farnborough, *Nature*, **180**, 937 (1957).

These values for the orbital elements were given for October 15. Using their values for the secular variations, the values for October 15 were extrapolated to October 21 for purposes of comparison.

Table 2. EXPLORER 1: 108 Mc./s.

	Feb. 4, 1958	Feb. 5, 1958	Feb. 6, 1958
Estimated exp. error	1·5 c./s.	1·5 c./s.	1·5 c./s.
Root-mean-square fit to observations	2·1 c./s.	2·5 c./s.	8·4 c./s.
Approximate ground-range	737 stat. miles	580 stat. miles	637 stat. miles
Minimum angle of arrival from horizon	0°	0°	0°
t_0	2.40.19 G.C.T.	0.01.37 G.C.T.	0.32.35 G.C.T.
Latitude of *O*	28° 33′ N.	38° 55′ N.	29° 25′ N.
Longitude of *O*	74° 54′ W.	78° 47′ W.	71° 13′ W.
Period	114 min. 37 sec.	114 min. 40 sec.	114 min. 37 sec.
Eccentricity	0·134	0·124	0·146
Inclination	28° 50′	32° 20′	29° 40′
Arg. of perigee	93° 50′	113° 50′	74° 30′
Longitude of asc. node	40′	340° 10′	340° 40′

COMPARISON OF ORBITAL DATA

Orbit element	Doppler determination (av.)	Minitrack determination
Period	114 min. 38 sec.	114 min. 57 sec.
Eccentricity	0·135	0·141
Inclination	30° 20′	33° 35′
Arg. of perigee	94°	120° 46′
Longitude of asc. node	347°	342° 57′

It should be emphasized that in each case the complete orbit was computed from observations taken at a single receiving station during a single pass of the satellite. It is evident that the accuracy attainable is quite reasonable, even for *Explorer I*, where the experimental circumstances were quite unfavourable, that is, the receiving station is so far north of the satellite orbit that even for the closest passes, and 'tracking' from horizon to horizon, an insufficient portion of the total Doppler curve was received.

These results suggest that an exclusively Doppler system in which observations from successive passes at two or more receiving stations (widely separated, but all near the orbit) are combined simultaneously in a single least-squares fit should provide a very competent method of tracking Earth satellites.

A detailed description of this analysis will be published in the near future, as will a more complete description of the experimental method.

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Photo-ionization in Self-quenching Geiger Counters

Korff and Present's[1] theory of self-quenching counters that the spread of the discharge is caused by photo-ionization has had no experimental support so far. On the contrary, it has been recently established[2] that radiations produced from a Townsend avalanche in a self-quenching Geiger counter give rise to photo-emission from the cathode sufficient to spread the discharge along the anode. These investigations do not, however, rule out the possibility of photo-ionization occurring in these tubes. The ultra-violet radiations produced from excited argon atoms in a Townsend avalanche are quite energetic, and may give rise to photo-ionization of polyatomic gas of the filling mixture. We have established experimentally in a simple but convincing manner that this is so.

Two counters, one 2·5 cm. in diameter and 5·5 cm. in length and the other 4·6 cm. in diameter and 6·0 cm. in length, were housed in a common glass envelope filled with argon–alcohol mixture containing 10 per cent alcohol at a pressure of 10 cm. mercury. The counters exchange photons, without their cathodes being exposed directly to them, through a narrow channel 2 cm. in length and 4 mm. in diameter fixed at the centre of a metal cap mounted at the end of the smaller counter. The choice of counter and channel diameters was based on two separate sets of experiments carried out for this purpose.

A collimated gamma-ray source placed beneath the small counter gives a counting-rate in it of 1,500–1,600 counts/min. and 400–500 counts/min. in the other. The pulses from these two counters were fed into a Harwell coincidence unit, type 1036-*B*, of resolving time 1 μsec. and the coincidence pulses were recorded in a Harwell scaler, type 200-*A*, at different over-voltages on the two counters. No coincidence pulses were observed at all when the voltage of the larger counter was on the Geiger threshold, irrespective of the voltage on the smaller counter in the Geiger region. Coincidence pulses were observed, however, as the over-voltage on the larger counter was increased. With the cap of the smaller counter removed, coincidences appeared even when both the counters operate at the Geiger threshold. Using a connecting channel of 1 mm. diameter, no coincidences were obtained at all unless the over-voltage on the larger counter was increased to 60–80 V.

The pulse-height at a particular voltage in the Geiger region is independent of the nature of the initial ionizing event, which in crossing the sensitive volume of the counter gives rise to a Townsend avalanche strong enough to breed others and so to cause the spread of the discharge along the anode. Accordingly, an electron starting from rest at the cathode and moving up to the anode will give rise to a Townsend avalanche as strong as that produced by the fast cosmic-ray particle. This is true for all values of voltages in the Geiger region. If, on the other hand, an electron at rest were produced say by a photon near the anode, it may not be able to build up a strong avalanche in travelling up this electrode under the existing field distribution at all points of the Geiger region. It may, however, develop a strong avalanche if the field distribution is changed by increasing the over-voltage on the counter. The value of the over-voltage needed by such an electron to produce a strong avalanche will depend upon the exact position where it is born with respect to the anode.

The increase in the counter voltage has no influence except on the field distribution in the counter volume, and hence we believe that the coincidence pulses which appear at increased over-voltages on the larger counter when a narrow beam of photons is fired in it is due to electrons produced by photo-ionization close to its anode. This also explains the increase in the number of coincidences with over-voltage.

To test that these coincidences were not due to photo-emission from the cathode surfaces caused by scattered photons, an aluminium counter was placed quite close to the large nickel counter in the same envelope, which thus now housed three counters. The coincidences obtained under similar experimental conditions with pulses from a large aluminium or a large nickel counter and those from a small nickel counter were found to be the same in any given

Table 1
Distance between the anode tips of the counters in coincidence, 5·7 cm. Working voltage on the small nickel counter with channel, 1,400 V.

Counter characteristics		
Counter	Plateau range (V.)	Plateau slope (per cent/V.)
(1) Small nickel counter	1,300–1,500	0·03
(2) Large nickel counter	1,500–1,680	0·03
(3) Large aluminium counter	1,440–1,640	0·04

Coincidences		
Over-voltage (V.)	No. of coincidences per 15 min. with : large aluminium counter	large nickel counter
0	Nil	Nil
20	7	6
40	9	9
80	11	10
120	11	11

interval of time within statistical differences. If photo-emission from cathodes due to scattered photons was appreciable, the number of coincidences with the aluminium counter should have been much larger. This was actually found to be the case when readings were taken with the cap of the small nickel counter removed; the percentage of coincidences with the aluminium counter was more than double and their number was more than 100 in 10 min.

The electrodes used in these experiments were all supplied by Messrs. Johnson Matthey and Co., Ltd., London. A typical set of results, which are reproducible, is given in Table 1.

We have checked that these coincidences are not due to the emission of photo electrons from the ends of the channel.

The details of these experiments will be given elsewhere.

We are grateful to H.M. Government for the generous gift under the Colombo Plan of electronic equipment and radioactive materials to our Nuclear Research and High Tension Laboratory, which has helped us in carrying out these experiments. We also thank Sir James Chadwick for his encouragement and interest in this work.

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Barometric Pressure and Altitude

OBSERVATIONS made by Pugh on Mount Everest in 1953 showed that the relationship between barometric pressure and altitude corresponded more closely with that of Zuntz, Loewy, Müller and Caspari[1] than with the internationally adopted altimeter calibration formula used in decompression chamber studies. In a review of the literature[2] he showed that observations made on other expeditions confirmed his findings.

In the summer of 1956, at the suggestion of Dr. Pugh, I made a series of barometric observations in the Karakoram Mountains of Northern Kashmir. An aircraft aneroid similar to that described by Pugh was used. This was calibrated before and after the expedition, and it was also shown to be insensitive to the temperature changes encountered in the Karakoram. Altitudes were derived from a survey[3] made during Shipton's expedition of 1939.

The results are shown in Fig. 1. They provide further evidence that a decompression chamber experiment, interpreted in terms of equivalent altitude on a mountain, would be misleading. The pressure conditions in such an experiment would be encountered at a considerably greater altitude than that derived from the generally adopted formula.

These observations formed a small part of the scientific work of the London School of Economics Mountaineering Club Himalaya Expedition 1956, and I gratefully acknowledge the collaboration of the members of the expedition and the financial support received from the Mount Everest Foundation, the Medical Research Council, and from the Central Research Fund of the University of London. The calibrations of the altimeter and the check on its temperature sensitivity were carried out by Mr. F. P. Ashworth of the Fairy Aviation Co., Ltd.

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The Middlesex Hospital,
London, W.1. April 7.

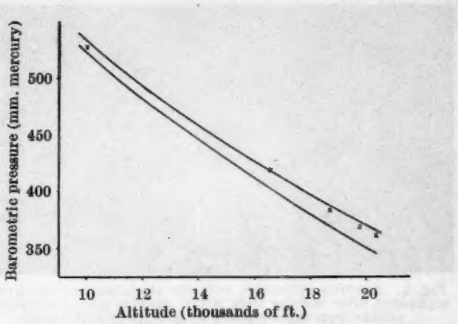

Fig. 1. The upper curve is plotted from the formula of Zuntz *et al.*[1] using a mean air temperature of 15° C. The lower curve is obtained from the internationally adopted altimeter calibration formula. The crosses represent observations made in the Karakoram Mountains in 1956

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Fine Aluminium Nitride Precipitates in Steel

FOR the past thirty years, aluminium has been commonly used in controlling the deoxidation, and thus the properties, of a number of steels. As a result of this practice there are important consequences if an appreciable amount of nitrogen is present. Aluminium in steel is known to be able to form one of the most stable nitrides. It is generally believed that under certain conditions aluminium nitride appears as inclusions after the solidification of the steel. Many investigators[1–5] have reported findings relative to aluminium nitride. Chemical and X-ray analyses of the residue have confirmed the presence of aluminium nitride in steel. Despite these claims, however, exact knowledge concerning the occurrence of aluminium nitride with respect to the structure of steel is not yet available. This communication reports the result of an attempt at identifying and separating fine aluminium nitride particles from a sample of nitrided vacuum-melted steel with the use of the electron microscope.

The sample prepared for this investigation was a small piece of steel having the following chemical analysis (per cent):

Carbon	0·084	Aluminium	0·035
Manganese	0·27	Nickel	0·019
Phosphorus	0·008	Chromium	0·055
Sulphur	0·008	Vanadium	0·003
Silicon	0·009	Molybdenum	0·009

The sample was decarburized, nitrided and then homogenized at 1,250° F. *in vacuo*. The standard mechanical polishing and 'Nital' etching method was employed for preparing the sample surface. The concentration of 'Nital' used was 1 per cent and the total etching time was about 15 sec. The freshly prepared sample was etched and inserted quickly into the diffraction column of an *RCA* type *EMU* electron microscope to minimize surface contamination by air. The operating potential of the

Fig. 1. Electron diffraction patterns of aluminium nitride and alpha-iron after etching with 'Nital', showing smooth aluminium nitride rings superimposed on spotty alpha-iron rings

Fig. 2. Electron micrograph of aluminium nitride particles (black) and their sites (white dots and rings) on 'Formvar' replica from a 'Nital'-etched steel surface

electron microscope was 50 kV. and the angle of incidence of the electron beam was about one degree.

Fig. 1 shows the reflexion diffraction pattern typical of the sample etched with 'Nital' reagent. The analysis of the patterns as listed in Table 1 indicates the presence of aluminium nitride and alpha-iron. The uniform nature of the aluminium nitride rings suggested that the particle size of aluminium nitride was very fine. An attempt was then made to isolate these particles from the steel sample. Immediately after etching a fresh sample, a 'Formvar' replica was dry-stripped with the hope that some aluminium nitride particles would come off together with the replica. Indeed, under fairly high magnifications, the size and distribution of these particles can be determined. Fig. 2 shows an electron micrograph of aluminium nitride particles (black) and the sites of the particles (white) on a 'Formvar' replica dry stripped from an etched steel surface. It appears that the average size of these aluminium nitride particles ranges from 100 A. to about 800 A. and higher. It seems that the distribution of these particles is random. However, a close examination of the micrograph reveals that they follow a sub-grain network structure throughout the sample. The light line just above the centre of the micrograph is a grain boundary. The black and white dots on the micrograph constitute the network pattern. The black dots are the actual aluminium nitride particles stripped from the sample surface, and the white dots and rings indicate the aluminium nitride dissolved during the process of etching, as aluminium nitride is soluble in water and slightly soluble in ethyl alcohol.

Table 1. Comparison of Diffraction Data

Observed data			Comparison data	
Ring radii (in.)	Corresponding d (A.)	Relative intensity	d_{AlN}* (A.)	$d_{\alpha\text{-}Fe}$† (A.)
0·90	2·69	Strong	2·70	
0·97	2·50	Strong	2·49	
1·03	2·35	Strong	2·36	
1·20	2·02	Very strong, spotty		2·02
1·31	1·85		1·83	
1·54	1·57	Strong	1·56	
1·69	1·43	Strong, spotty	1·42	1·43
1·78	1·36		1·35	
1·82	1·33		1·33	
1·92	1·26		1·25	
2·05	1·18	Strong spotty	1·20	1·17
2·37	1·02	Spotty		1·01
2·64	0·917	Spotty		0·905
2·90	0·835			0·828
3·12	0·776	Spotty		0·765
3·56	0·680	Spotty		0·674

* ASTM X-ray card index. † Calculated from $a_0 = 2{\cdot}857$ A.

This is perhaps the first time that the aluminium nitride in steel has been successfully determined *in situ* with detailed locations of the particles in sub-boundaries of grains. It seems quite clear that a process of polygonization has occurred which is a movement of dislocations into planes that form subgrain boundaries where aluminium nitride particles are situated. However, it is interesting to note that the grain boundary in Fig. 2 does not indicate any evident concentration of the fine aluminium nitride precipitates.

In addition, the corrosion and inhibition problem of the steel loop containing aluminium and nitrogen in liquid fuel reactor systems is of great interest[6]. The mechanism of the inhibiting process is that the metallic additive, such as zirconium, in the bismuth liquid reacts with nitrogen present in the steel to form zirconium nitride on the steel surface. Any constituents which reduce the activity of nitrogen in a steel interfere with the formation of zirconium nitride in that they reduce the concentration of nitrogen available[7]. Therefore the uniform distribution of the aluminium nitride precipitates in the subgrain structure in steel seems to indicate that the presence of aluminium may affect the inhibiting process not only in the interior but also on the surface of the steel loop.

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Effect of Water upon the Polymorphic Transitions in Anhydrous Sodium Sulphate

THE polymorphism of anhydrous sodium sulphate is well known[1–4] and the latent heats associated with its two transitions (orthorhombic form V to the orthorhombic form III at 177° C., and III to the hexagonal form I at 241° C.) have recently been determined by J. P. Coughlin[5].

In the course of an investigation of the thermal properties of this material, we measured its heat capacity over a range of temperatures from 37° to 320° C. using a water calorimeter and partially encapsulated samples. Under these conditions, we were able to observe only the upper transition at approximately 238° C., and we determined the corresponding heat of transition as approximately 23 kcal./mole (making a correction for the heat of solution of the amount of salt dissolved). This value is considerably larger than the value 16·80 kcal./mole obtained by Coughlin[5] for the upper (III–I) transition, and it is actually closer to the sum of this value plus that of the lower (V–III) transition (7·40 kcal./mole), namely, 24·20 kcal./mole.

Thus, it appeared that in presence of water the high-temperature hexagonal form I is inverted directly into the low-temperature form V. This is unusual since the transition V–III is normally irreversible and the salt remains in the metastable form III, when once heated over the transition temperature.

We were able to observe the complete inversion of samples brought to the form I (above 250° C.) by water-quenching the heated samples on a hot-stage X-ray diffractometer. Fig. 1 shows the powder patterns obtained on (*a*) the metastable form III, (*b*) the hexagonal form I at 305° C. and (*c*) the low-temperature form V after water-quenching from 300° to 78° C. Comparison of the powder pattern *c* with that of the original form V shows complete identity and thus confirms that water acts as a mineralizer making the V–III transition reversible.

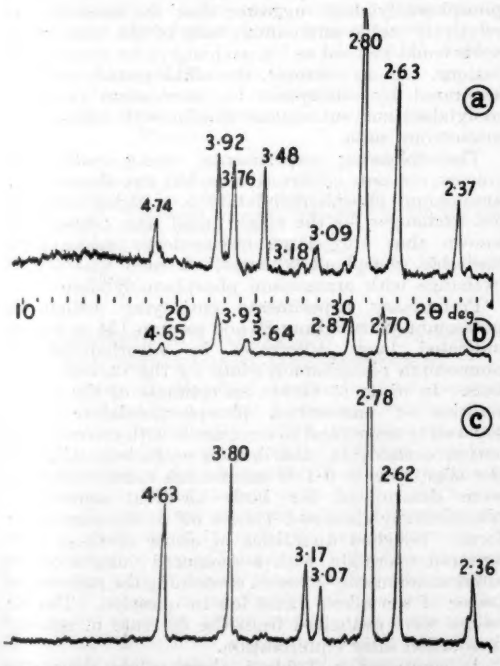

Fig. 1. (*a*) Sodium sulphate (III), before heating; (*b*) sodium sulphate (I) at 305° C.; (*c*) sodium sulphate (V), after water quench

We wish to acknowledge the co-operation of the Whirlpool Corporation of St. Joseph, Michigan, which sponsored the research project, in the course of which these observations were made.

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Arthur D. Little, Inc.,
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March 31.

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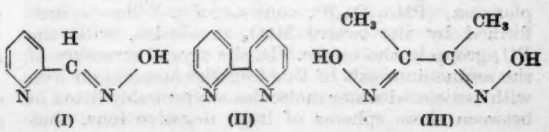
Complexes of Nickel(II) with 2-Pyridinaldoxime

THE complexing properties of 2-pyridinaldoxime (I) would be expected to follow from those of 2,2′-bipyridine (II) and dimethylglyoxime (III) since this new ligand incorporates in its structure the functional groups of both the latter substances. In the course of synthesizing and characterizing the nickel(II) complexes of pyridinaldoxime (HPAO) it has become apparent that some very unusual deviations from the expected behaviour occur. By analogy with the nickel(II) complexes of 2,2′-bipyridine[1], two complexes containing molecular pyridinaldoxime should form: *bis*(pyridinaldoxime)nickel(II) and *tris*-(pyridinaldoxime)nickel(II). In addition, a third complex, containing one molecule of pyridinaldoxime co-ordinated to each nickel(II) atom, might also be expected to exist. The first two complexes, $[Ni(HPAO)_2]^{++}$ and $[Ni(HPAO)_3]^{++}$, have been prepared as the chloride and iodide salts, respectively. The *bis* complex is prepared by mixing 1 mole of nickel chloride 6-hydrate with 2 moles of the ligand in hot absolute ethanol. The compound is precipitated as fine green crystals. The *tris* complex may be isolated as fine tan crystals by mixing 3 moles of ligand with 1 mole of nickel(II) chloride in aqueous solution, followed by the addition of solid potassium iodide. The colour changes occurring in aqueous solutions indicate that the *bis*-pyridinaldoxime complex is considerably less subject to disproportionation, and consequent formation of the *tris* complex, than is true of the corresponding 2,2′-bipyridine complex. Both the *bis* and *tris* complexes containing the neutral pyridinaldoxime molecule are paramagnetic, having corrected effective magnetic moments of 3·16 and 3·12 Bohr magnetons, respectively. It may be concluded that these compounds are normal representatives of the classes of nickel(II) complexes formed by the aromatic heterocyclic diamines and other related ligands.



(I) (II) (III)

The nickel(II) complexes with this ligand would be expected to resemble those of dimethylglyoxime when the oxime functions are ionized. The most simply characterized complex produced by treating $[Ni(HPAO)_2]^{++}$ with base is, however, a species which appears to contain a unit of the formula $[Ni(PAO)_2H]^+$. This complex bears some resemblance to the planar, bridged cationic complexes described by Murmann[2]. The bridged cation, *bis*(2 - methyl - 2 - amino - 3 - butanoneoxime)-nickel(II), is diamagnetic[2] and presumably contains four-coordinate, planar nickel(II). A very different behaviour has been observed in the case of pyridinaldoxime. The complex iodide and acetate salts have been prepared. These are of the formulæ $[Ni(PAO)_2H]$ I and $[Ni(PAO)_2H]$ $C_2H_3O_2$. The acetate is first prepared from $[Ni(HPAO)_2]$ $(C_2H_3O_2)_2$ simply by dissolving the reactant in 90 per cent ethanol and precipitating with ether. Conversion to the iodide is accomplished with 1 mole of potassium iodide in aqueous solution. The resulting iodide salt is paramagnetic ($\mu_{eff.}$, 2·91 Bohr magnetons) and only slightly soluble in water. The iodide appears to be bound to the nickel(II) atom since the addition of silver nitrate does not result in the separation of a silver iodide precipitate. Furthermore, the silver ion appears to coordinate with the nickel(II) complex, since the added silver ion cannot be precipitated with chloride. A 'supercomplex', such as $\{[Ni(PAO)_2HI]_2Ag\}$, appears to be formed.

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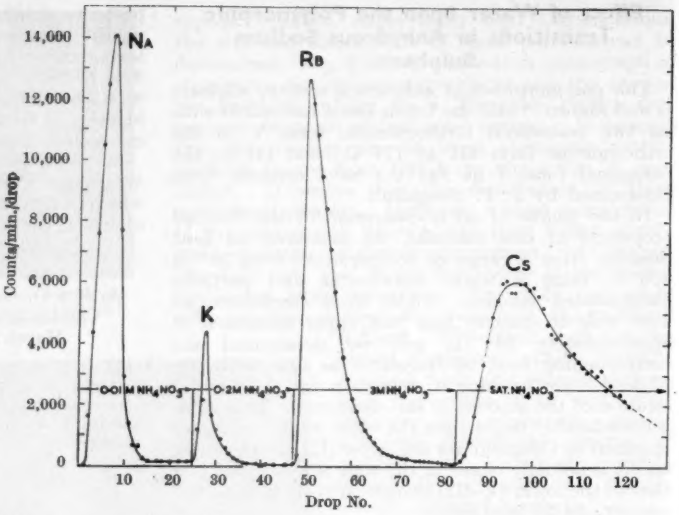

Fig. 1. Ion exchange separation of the alkali metal ions on a column of ammonium phosphomolybdate, 1·6 mm. × 5 mm. in diameter

Ammonium Salts of the Heteropolyacids as Cation Exchangers

Terlet and Briau[1] have found that variable amounts of the ammonium ions in an ammonium phosphomolybdate precipitate may be displaced by potassium ions, and to a lesser extent by sodium ions, when the precipitate is washed with neutral potassium nitrate or sodium sulphate solutions. These observations have been confirmed by Gisiger[2] and by Thistlethwaite[3], who have found that approximately two of the three ammonium ions are exchanged for potassium.

According to Wells[4], the phosphomolybdate complex ion, $(PMo_{12}O_{40})^{3-}$, consists of a hollow sphere formed by the twelve MoO_6 octahedra, with the PO_4-group in the centre. In the crystal structure of the ammonium salt of this ion, the ammonium ions with associated water molecules are probably fitted in between these spheres of large negative ions, thus accounting for the cohesion of these ions. It can reasonably be assumed that relatively large interspaces exist between these spheres, so that larger ions could be accommodated with ease. Therefore, if larger ions are substituted for the ammonium ions it is likely that the larger the displacing ion, the more stably it will be packed into the structure.

The observations cited above and the inferences made from the crystal structure of ammonium phosphomolybdate suggested that the insoluble and relatively stable ammonium salts of the heteropolyacids could be used as ion exchangers for monovalent cations. As an example, the alkali metals could be separated by adsorption on ammonium phosphomolybdate and subsequent elution with solutions of ammonium salts.

The following experiments, using radioactive tracers, not only confirmed this, but also showed that ammonium phosphomolybdate is a highly selective ion exchanger for the alkali metal ions. Since it is known that only large monovalent cations form insoluble phosphomolybdates, all such ions should exchange with ammonium phosphomolybdate.

Preliminary experiments employing sodium-24, potassium-42, rubidium-86 and cæsium-134 as tracers indicated large differences in adsorbability on ammonium phosphomolybdate for the various alkali ions. In order to obtain an estimate of the potentialities of ammonium phosphomolybdate as a separating agent, and to compare it with conventional cation exchangers, distribution coefficients (K_d) for the alkali ions in 0·1 *M* ammonium nitrate solutions were determined for both air-dried ammonium phosphomolybdate and 'Dowex 50' in the ammonium form. Weighed quantities of either of these were agitated overnight with a measured volume of the ammonium nitrate solution containing the radioactive tracer of the alkali metal ion in question. The K_d values were evaluated from the decrease in activity in solution after equilibration.

As compared in Table 1, these values show considerably larger differences in adsorbability with ammonium phosphomolybdate than with 'Dowex 50'.

Table 1. DISTRIBUTION COEFFICIENTS, K_d, IN 0·1 *M* AMMONIUM NITRATE

	Cæsium	Rubidium	Potassium	Sodium
'Dowex 50'	62	52	46	26
Ammonium phosphomolybdate	6,000	230	3·4	~0

A small quantity of ammonium phosphomolybdate was packed in a glass column 5 mm. in diameter to give a bed only 1·6 mm. high. Two drops of a solution containing trace amounts of radioactive sodium, potassium, rubidium and cæsium salts were added to the top of the column. Using a column-head 11 cm. high, elution was carried out with solutions of ammonium nitrate of different concentrations. The initial flow-rate was about one drop per minute. Drops of the effluent were collected on 'Perspex' trays, dried under an infra-red lamp and counted with an end-window counter.

A complete separation was obtained, as is shown in Fig. 1. It should be noted that an equivalent separation of these ions, using 'Amberlite *IR*–100', has been achieved by Kayas[5] by first eluting sodium and potassium with 0·1 *N* hydrochloric acid and rubidium and cæsium with 1 *N* acid, but this required a column 1 cm. in diameter and 40 cm. high, which is nearly 250 times longer than the present one.

This work forms part of a more comprehensive study the results of which will be published elsewhere. I am indebted to Prof. L. J. le Roux for helpful discussion, and to the South African Council for Scientific and Industrial Research for permission to publish this work.

Note added in proof. This communication was submitted originally on June 10, 1957, but later withdrawn to allow application to be made for a provisional patent. In the meantime, a paper which directs attention to the cation exchange properties of ammonium phosphomolybdate has appeared[1].

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Cytochemical Localization of Pyridine Nucleotide-linked Dehydrogenases

THE intramitochondrial localization of succinic dehydrogenase by a metal formazan technique has already been reported[1,2]. With modifications this technique can be used to localize different pyridine nucleotide-linked dehydrogenase–diaphorase systems.

It has been found that in such systems the tetrazolium salt can accept electrons only if the respiratory enzyme chain is fully reduced, and this state is achieved by the use of inhibitors of the type studied by Chance and Williams[3] and others. Mere withdrawal of oxygen is insufficient fully to reduce the respiratory chain in tissue sections, since anaerobic incubation allows little reduction of the tetrazolium salt by any of the dehydrogenase–diaphorase systems unless reduced pyridine nucleotide or exogenous dehydrogenase is added[4].

We have tested the following inhibitors: amytal, sodium azide, sodium cyanide, urethane, phthiocol (2-hydroxy-3-methyl-1,4-naphthoquinone) and quinacrine. The fastest reactions were obtained with the first three compounds, whereas the last two were without effect. Osmotic protection of the tissues before and during incubation[5] was found to be absolutely essential in order to minimize diffusion of soluble enzyme systems.

Cold microtome (cryostat) sections of fresh rat tissues were cut at 4–8μ and mounted on clean coverslips. These were incubated for 15–45 min. at 37° C. in a mixture containing substrate, coenzymes 1 or 2, phosphate or *tris* buffer (*p*H 6·8–7·0), magnesium chloride, polyvinyl pyrrolidone and the respiratory inhibitor. With β-hydroxy-butyrate and glucose-6-phosphate as substrates the final electron acceptor was 3(4,5-dimethylthiazolyl-2)-2,5-diphenyl tetrazolium bromide in the presence of cobaltous ions. In dehydrogenase systems producing α-keto acids, cyanide was necessary as respiratory inhibitor and binding agent for the keto-groups. This forms a hexacovalent complex with Co^{3+} and an unpaired electron is produced by *d–s–p* hybridization which reduces the tetrazolium salt. In these systems we therefore used 2,2′-di-*p*-nitrophenyl-5,5′-diphenyl-3,3′(3,3′-dimethoxy-4,4′-biphenylene) ditetrazolium chloride (Nitro-BT)[6,7] as the final electron acceptor. Full details of the methods will be published elsewhere.

Enzymes using coenzyme 1 demonstrated so far include β-hydroxybutyric, glutamic acid, α-glycerophosphate, lactic acid, and alcohol dehydrogenases. Glucose-6-phosphate dehydrogenase using coenzyme 2 has also been found. Its activity can be greatly increased by blocking the glycolytic pathway with fluoride. All these systems were localized in the mitochondria and when the tetrazolium bromide–cobalt method was used the characteristic dot-like pattern was evident. Fig. 1 shows β-hydroxybutyric dehydrogenase in isolated mitochondria from the fat body of *Locusta migratoria* and Fig. 2 mitochondria of a distal tubule cell in rat kidney. Distinct distribution patterns were shown by each dehydrogenase system and these were especially clear in stomach and kidney.

We consider that with the methods described here the specific dehydrogenases are solely responsible for the deposits of formazan or metal-formazan and that these represent a true localization of the enzyme, since the coenzyme-linked flavoprotein diaphorases participate only in the *in loco* electron transfer. If reduced di- or tri-phosphopyridine nucleotides in a concentration equal to that of the substrate are added to the medium, the specific dehydrogenase pattern disappears and is replaced by the non-specific pattern of the diaphorase with its much wider distribution.

The need to use the oxidized di- or tri-phosphopyridine nucleotides in our incubating media in concentrations equal to that of the substrate is explained by the fact that damaged mitochondria no longer depend on their internal diphosphopyridine nucleotide[8]. In spite of the morphological integrity of our protected mitochondria it is probable that freezing and thawing in the cold microtome produce alterations in the mitochondrial membrane. This procedure is also responsible for the uncoupling of oxidative phosphorylation[8], which explains the failure of low concentrations of dinitrophenol to affect the enzyme reactions.

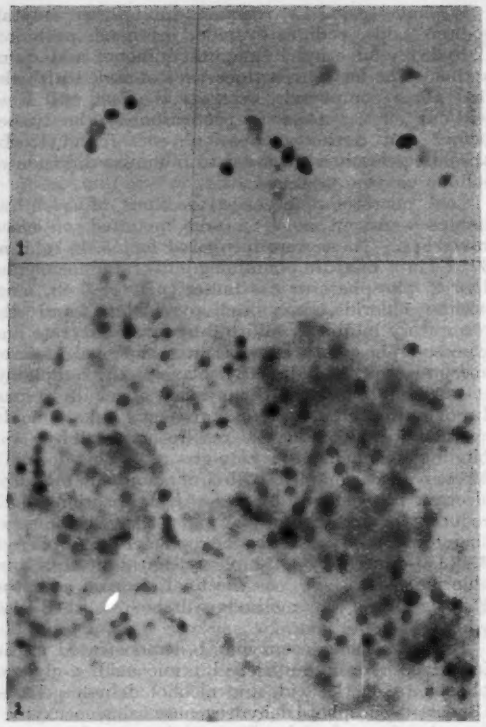

Fig. 1. Isolated mitochondria from *Locusta migratoria* showing β-hydroxybutyric dehydrogenase. × 4,400

Fig. 2. Cell of distal tubule of rat kidney showing mitochondrial localization of β-hydroxybutyric dehydrogenase. × 4,400

We found that reduction of the tetrazolium salt was greatly increased by amytal in both the succinic dehydrogenase and β-hydroxybutyric dehydrogenase–diaphorase systems. This observation is at variance with Chance's[10] suggestion that amytal acts by blocking the flavoprotein stage of the respiratory chain. It suggests rather that blocking occurs at a point common to both electron transfer systems, namely, Slater's factor. We postulate that tetrazolium salts interact with the respiratory chain at this level.

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Leucine Aminopeptidase in Rat Parathyroid and its Relation to Parathyroid Hormone Production

Although leucine aminopeptidase is widely distributed in mammalian tissues[1] its physiological importance remains obscure. This communication concerns the demonstration of the enzyme in rat parathyroid and of alterations in its activity during various functional states.

The glands were removed from the animals with a thin rim of adjacent thyroid tissue and embedded in liver to prevent distortion during sectioning. Fresh frozen 8-μ sections were cut on a remotely controlled cold microtome (cryostat) and incubated in a medium containing L-leucyl-β-naphthylamide hydrochloride, as described by Nachlas *et al.*[2].

The intensity of the reaction in the normal parathyroid gland (Fig. 1*a*) was comparable to the high activity observed in the rat kidney[2].

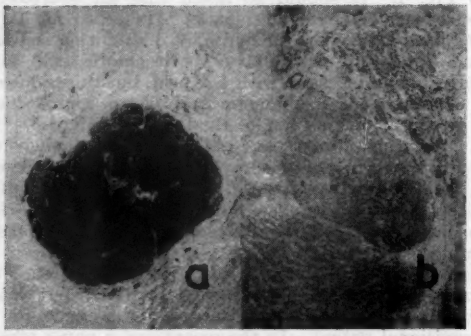

Fig. 1. Leucine aminopeptidase activity in parathyroid gland of (*a*) a normal rat, and (*b*) a rat treated with dihydrotachysterol. The background staining of the thyroid and liver tissue is due to decomposed diazonium salt. (Incubation time, 35 min.) × 120

The relation of parathyroid function to leucine aminopeptidase activity was investigated as follows: Ten hooded male rats, each weighing between 205–235 gm., were given 0·625 mgm. of dihydrotachysterol (A.T.10) daily by stomach tube for a period varying between 15 and 21 days. Male hooded rats of comparable weight served as controls. Following this treatment the leucine–aminopeptidase activity of the parathyroids decreased sharply (Fig. 1*b*). A second group of six rats 45–55 gm. were placed on a diet low in calcium, free of vitamin D, and rich in phosphorus, similar to that described by Crawford *et*

Fig. 2. Leucine aminopeptidase activity in the parathyroid gland of (*a*) a normal young rat, and (*b*) a rat maintained on a low-calcium diet. (Incubation time, 25 min.) × 120

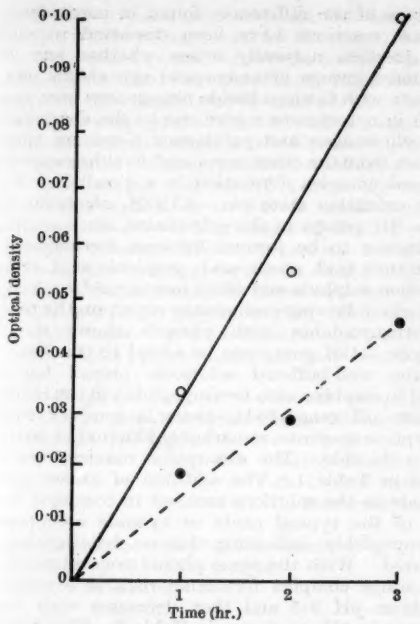

Fig. 3. Leucine aminopeptidase activity in homogenates of parathyroid glands of normal rats O——O and rats treated with dihydrotachysterol ●- - - -●

al.[4], for 18–21 days. Leucine aminopeptidase activity was significantly above that of control rats of the same weight range (Figs. 2*a* and *b*).

The fall in enzymatic activity in hypercalcæmia was measured in homogenates. Four glands from two untreated rats serving as controls and from two rats treated with dihydrotachysterol for 15 days were removed and homogenized in a Potter–Elvehjem homogenizer in 1 ml. of distilled water. Quantitative estimation of enzymatic activity was made in the homogenate by the colorimetric method of Green *et al.*[3]. The results are shown in Fig. 3.

The above results suggest that there is a close correlation between leucine aminopeptidase activity and parathyroid hormone production.

The purest preparation of parathyroid hormone so far obtained[5] is a mixture of polypeptides; its constituent amino-acids and the order of their occurrence have not been determined. We suggest that the function of leucine aminopeptidase may be (1) synthetic, or (2) hydrolytic. If hydrolytic it may act by splitting the active hormone from the larger protein molecule constituting the precursor or carrier. In this case either the hormone or the hormone-free carrier must possess a terminal leucyl group.

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Enzymatic Cleavage and Synthesis of L-threo-β-Phenylserine and L-erythro-β-Phenylserine

As has been demonstrated in earlier communications, D,L-threo-β-phenylserine-3-^{14}C and D,L-phenylalanine-3-^{14}C are incorporated into the benzoyl moiety of urinary hippuric acid[1,2]. These results led to the assumption of an enzymatic, *in vivo* splitting between C_2 and C_3 of the side-chain, as has been found to occur *in vitro* for L-phenylserines[3,4].

As a first step in investigating the reaction mechanism of hippuric acid formation, detailed studies were undertaken on the enzymatic cleavage of the L-threo compound and the synthesis of both the L-threo and L-erythro isomers. The enzyme action,

L-threo-β-phenylserine ⇌ benzaldehyde + glycine

was estimated by measuring the rate of benzaldehyde formation in trichloroacetic acid filtrates as the 2,4-dinitrophenylhydrazone. The method of determination of enzyme activity was chosen after establishing optimum conditions. Under these conditions the response is linear with enzyme concentration and with time until about 20 per cent of the L-hydroxy-amino-acid has been cleaved. Equivalent amounts of benzaldehyde and glycine accumulate in the incubation mixture. The D-form is not attacked. The optimum *p*H was found to be 7·6 in systems buffered with collidine. Lower activities were found with *tris*(hydroxymethyl)-aminomethane and borate buffers. Phosphate inhibits the reaction. The dissociation constant of the enzyme-substrate intermediate was 6×10^{-3} L-threo-phenylserine/mole/l. The optimum temperature was found to be 55° C. From the proportionality of log v_i/T (v_i, maximum initial reaction velocity; T, absolute temperature) the heat of activation was evaluated as $\Delta H^* = 24{\cdot}6$ kcal./mole.

Pyridoxalphosphate is necessary as a coenzyme. Though no direct activation by the co-factor was obtained with dialysed rat liver preparations, a strong inhibitory action by hydroxylamine ($1{\cdot}5 \times 10^{-5}$ *M* gives 50 per cent inhibition) indicates that tightly bound pyridoxalphosphate might be a coenzyme. A direct requirement for pyridoxalphosphate was found in experiments with dialysed sheep liver preparations (K_m, 0·0001). Furthermore, strong inhibition by *p*-chloromercuribenzoate showed that the enzyme needs free —SH groups for activity. Monoiodoacetate and versene did not influence the enzyme action.

The enzyme is present in livers and kidneys of men, rats, mice, guinea pigs, pigs, sheep and cows. No activity was found in skeletal muscle, heart muscle, brain, spleen, adrenals, red cells, plasma or serum. The enzyme is soluble in water and buffers. Measurement of activity may be performed on crude homogenates, fresh extracts, or extracts from acetone powders (500 mgm. powder and 10–25 ml. collidine buffer, 0·1 *M*, *p*H 7·6). Cleavage of the hydroxy-amino-acid will stop when about 60 per cent of the L-threo form has been converted to benzaldehyde and glycine. Calculation of the equilibrium constant was unsuccessful: the reason may be that the final equilibrium was not achieved due to partial recondensation and formation of L-erythro-β-phenylserine.

Synthesis of L-threo-β-phenylserine and L-erythro-β-phenylserine from benzaldehyde and glycine is catalysed by acetone powder extracts from liver and kidney. The diastereoisomers can be separated easily

by the paper chromatographic method of Shaw and Fox[5]. As solvent system a mixture of *n*-butanol/acetone/ammonia/water (50 : 6·25 : 6·25 : 37·5) was used. The hydroxy-amino-acids were developed with ninhydrin or by the more specific periodate method. Furthermore, acetone powder extracts catalyse the enzymatic splitting of L-threo-β-thienylserine to thiophene-2-aldehyde and glycine and the synthesis of the L-threo and the L-erythro compounds from the breakdown products. It seems possible that two different enzymes exist for the L-threo and the L-erythro forms, respectively. This would be an analogy with the results of Karasek and Greenberg[6], who obtained evidence for the presence of two different enzymes in sheep liver that cleave L-threonine and L-allothreonine to acetaldehyde and glycine. The enzyme cleaving L-threo-phenylserine is distinct from threonine aldolase, since there is variation in the activity ratio,

(μmoles L-threo-phenylserine cleaved/mgm. protein)/(μmoles L-threonine cleaved/mgm. protein)

for different enzyme preparations on the two substrates. The ratio observed varied between 1·6 and 9·7. Furthermore, the specific activities changed during thermal inactivation. Phosphate inhibits the breakdown of phenylserine but not of threonine. Hence, because of the similarity of the enzymatic reaction investigated to aldol condensations, the enzyme may be named phenylserine aldolase. This enzyme is also distinct from serine aldolase since no requirement for tetrahydrofolic acid could be demonstrated. Specific enzyme activities decrease in livers and kidneys of starving rats and in livers of animals poisoned with carbon tetrachloride. A detailed report of this work will be given elsewhere[7].

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Reaction of Ferrimyoglobin with Phenols

If, in a hæmoprotein, the hæm iron atom is held by bonds to the protein on both sides of the porphyrin ring, then the most likely mechanism for complex formation with the ligands CO, NO, F^-, CN^-, N_3^-, etc., entails breaking the weaker bond while leaving the stronger bond intact. The proton affinity of the group thus liberated would be an important factor in determining the *p*H variation of the equilibrium constants for complex formation. The limited extent to which such a mechanism can account for hæm-linked ionizations in hæmoglobin reactions, its direct application to cytochrome *c* reactions, and the way it can account for some of the differences found in peroxidase and catalase reactions have been discussed recently[1,2]. The question naturally arises whether any other functional groups in amino-acid side-chains can co-ordinate with the iron beside nitrogenous base groups, which in cytochrome *c* give rise to the characteristic hæmochromogen and parahæmatin spectra that set it apart from the other ferro- and ferri-hæmoproteins. Internal complex formation is a possibility in the ferric oxidation state *via* —COOH, alcoholic —OH and —SH groups in the side-chains, since complexes are known to be formed between ferrihæmoglobin and formic acid, acetic acid, propionic acid, ethanol, hydrogen sulphide and ethyl mercaptan[3–6]. Furthermore, the following preliminary report on the reaction of ferrimyoglobin with phenols shows that the phenolic —OH group can be added to this list.

Using well-buffered solutions, phenol has been found to combine with ferrimyoglobin in the relatively alkaline *p*H range 8–11, giving a complex with an absorption spectrum remarkably like that of ferrimyoglobin fluoride. The absorption maxima are compared in Table 1. The addition of excess azide or cyanide to the solutions resulted in complete formation of the typical azide or cyanide complexes of ferrimyoglobin, indicating that no denaturation had occurred. With the same phenol concentration, the percentage complex formation rises to a maximum at about *p*H 9·5 and then decreases with further increase in *p*H, as shown in Table 2. This indicates that the phenoxide ion PhO^- is bound directly to the iron as HO^- is in the generally accepted structures for alkaline ferrimyoglobin and ferrihæmoglobin. By analogy the bonding of EtO^- would be anticipated in an ethanol complex, but, from the data available on the ferrihæmoglobin reaction, it has been argued that the compound in alkaline solution has the structure Hb(OH)EtOH[4].

Table 1. Absorption Bands for Ferrimyoglobin Derivatives between 300 and 650 mμ
(Values in brackets indicate weak absorption bands or the appearance of a shoulder)

Fluoride	608, (554), 490, 407, (350)
Phenol	610, (560), (530), 496, 404, (350)
Cyanide	(575), 540, 423, (358), (340)
Thiophenol	(565), 540, 423, (363)

Table 2. Percentage Formation of the Complex with 0·02 *M* Phenol over the *p*H Range 8–11. Ionic Strength, 0·12; Temperature, 8·9° C.

*p*H	Buffer	Percentage complex
8·1	Pyrophosphate	4·2
8·9	Borate	38·9
9·5	Borate	48·9
10·2	Borate	43·5
10·9	Phosphate	12·3

With concentrations of 10^{-2}–10^{-1} *M*, the *ortho*, *meta* and *para* chloro- and bromo-phenols have been found to give complexes similar to that formed by phenol itself. On the other hand, thiophenol, in much lower concentrations of about 10^{-4} *M*, gives a complex with absorption maxima like those of the hydrogen sulphide and cyanide derivatives (see Table 1). The correlation between absorption spectra and magnetic properties noted for other hæmoprotein derivatives[7] suggests that the phenol and thiophenol complexes will be found to have paramagnetic susceptibilities corresponding to five and one unpaired electrons respectively.

Attempts have been made to construct a molecular model of the Courtauld design with the phenoxide group joined to the iron in the porphyrin ring. Considering data for other co-ordination complexes an Fe—O bond distance of 1·2–1·3 A. would be anticipated

and an Fe—O—C bond angle between 110° and 125°, in keeping with the values found for the corresponding angle in ethers and esters. However, on this basis it was found that the van der Waals radii at the periphery of the phenyl group and at the line of contact on the porphyrin ring are of such a magnitude that steric hindrance occurs and the Fe—O—C linkage cannot be made. An appreciable decrease in the van der Waals radius of about 0·3 A. from the values chosen for the models, or an Fe—O bond length of 1·5 A., or an Fe—O—C bond angle of 135°, or some compromise between these extremes would be required. In any event, groups *ortho* to the phenolic oxygen would be expected to show van der Waals interaction with the porphyrin ring to a greater extent than *meta*- or *para*-substituents, and the interaction might play a significant part in complex formation.

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Formation of a Glycoside of Maleic Hydrazide in Plants

MALEIC hydrazide is widely used as a growth inhibitor in plants. Its activity as a plant growth regulating substance was described so long ago as 1949 [1] and it is used to arrest sprouting in stored root crops, for the temporary inhibition of growth of lawn grass and hedges and for the prevention of the formation of suckers in tobacco. It is translocatable in plants and is toxic to meristematic tissue causing a loss of apical dominance[2]. Little seems to be known about the fate of this compound in plants, or the mechanism whereby it exerts its effects. It has been shown to accelerate the destruction of indoleacetic acid *in vitro*[3] and, in this behaviour, resembles monohydric phenols which are required in the indoleacetic acid oxidase system[4]. Maleic hydrazide exists as 6-hydroxy-3(2H)-pyridazinone[5] and may be expected to exhibit phenolic properties under physiological conditions.

As part of our studies on the formation of phenolic glucosides in plant tissues[1], maleic hydrazide-^{14}C or maleic hydrazide and glucose-^{14}C were fed to leaf segments of five species, apple, *Malus pumila* Mill., willow, *Salix purpurea* L., tobacco, *Nicotiana rustica* L. and *N. sanderae* and wheat, *Triticum vulgare* Vill. An experiment with young wheat leaf segments is described below.

Terminal segments (15 per treatment) of young wheat leaves were infiltrated under vacuum with tap-water, blotted and placed in radioactive solutions contained in small Petri dishes. Four types of solution were used: maleic hydrazide and glucose-^{14}C, maleic hydrazide-^{14}C and glucose, glucose-^{14}C alone and maleic hydrazide-^{14}C alone. 2 μc. of radioactive compound was fed in each treatment. After 12 hr. the segments were removed, washed thoroughly with tap-water and extracted with boiling 80 per cent ethanol. The ethanolic extract was subjected to chromatography directly on Whatman No. 1 paper, the solvents being phenol saturated with water for the first direction and the upper phase of a mixture of *n*-butanol/acetic acid/water (4 : 1 : 5) for the second. Radioautographs were prepared from the dried chromatograms.

Maleic hydrazide-^{14}C, with or without glucose, gave rise to a new radioactive spot (*U*1) on radioautographs. Spot *U*1 accounted for 15 per cent of the total activity in the 80 per cent ethanol-soluble fraction, nearly all the remaining activity being located in maleic hydrazide-^{14}C. A second faintly radioactive compound (*U*2) was also detected, its activity amounting to a fraction of 1 per cent. The positions of these compounds on radioautographs are shown in Figs. 1 and 2. Glucose-^{14}C alone gave rise to radioactive fructose and sucrose and a number of unidentified compounds. Leaf segments fed glucose-^{14}C together with maleic hydrazide, however,

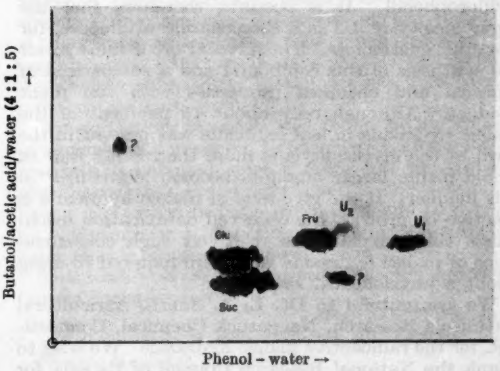

Fig. 1. Radioautograph prepared from chromatogram of 80 per cent ethanol-soluble extract of wheat leaf segments fed with maleic hydrazide and glucose-^{14}C. *Glu*, glucose; *Fru*, fructose *Suc*, sucrose; *U*1, maleic hydrazide glycoside; *U*2, unknown

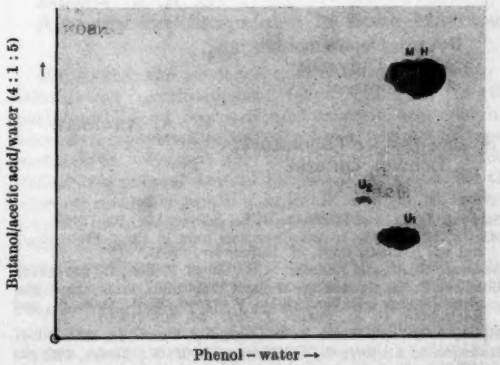

Fig. 2. Radioautograph prepared from chromatogram of 80 per cent ethanol-soluble extract of wheat leaf segments fed with maleic hydrazide-^{14}C. *MH*, maleic hydrazide; *U*1, maleic hydrazide glycoside; *U*2, unknown

gave *U*1 (accounting for 6 per cent of the total activity in the 80 per cent ethanol-soluble fraction) in addition to these compounds. Radioactive *U*1 was eluted from chromatograms with 80 per cent ethanol, the eluates dried under air-jets and the residues taken up in small volumes of water. Aliquots were hydrolysed with (1) 2 *N* hydrochloric acid for 2 hr. or (2) a commercial preparation of emulsin for 19 hr. The hydrolysis products were chromatographed two-directionally together with standard maleic hydrazide and glucose. *U*1 obtained from the glucose-^{14}C and maleic hydrazide feeding gave glucose-^{14}C with either acid or emulsin hydrolysis. *U*1 obtained from the maleic hydrazide-^{14}C feedings gave maleic hydrazide-^{14}C and inactive glucose on either acid or emulsin hydrolysis. Glucose was detected with the benzidine–trichloracetic acid reagent[7]. Maleic hydrazide-^{14}C was identified by co-chromatography with the radioactive maleic hydrazide which had been fed to the tissue. Due to residual phenol on the chromatograms it was not possible to detect maleic hydrazide with the ferric chloride–ferricyanide reagent[8].

The identification of glucose and of maleic hydrazide as the hydrolysis products of *U*1 and the fact that hydrolysis is achieved with emulsin indicate that this compound is a β-glucoside of maleic hydrazide. Miller[9] has shown that some plants readily synthesize gentiobiosides when fed with chloral hydrate or *o*-chlorophenol. It is possible, therefore, that the sugar moiety of *U*1 is a disaccharide of glucose, for example, gentiobiose. Unequivocal proof must await the synthesis of this compound and a comparison of physical and chemical properties with the plant product. Although only about 15 per cent of the maleic hydrazide in leaf segments was present in the form of the glycoside, it is more than likely that in whole plants larger amounts become 'detoxified' in this manner. If the glycoside of maleic hydrazide is inactive on growth, the observed detoxication mechanism could explain the relatively high concentrations of maleic hydrazide which are required to bring about a physiological response.

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Acquired Resistance to Experimental Allergic Encephalomyelitis

The existence of acquired resistance against experimental allergic encephalomyelitis has been revealed in the course of our study of the ontogenetic development of the encephalitogenic factor in rabbit brain[1].

In contrast with previous workers[2] we find that the brain of rabbits more than 48 hr. old reveals lowered but quite definite encephalitogenic activity, and only the brain of rabbit embryos and one-day-old rabbits contains no encephalitogenic factor.

In the present study it was shown that the administration of the brain of rabbit embryos or of one-day-old rabbits mixed with an adjuvant of the Freund type does not cause experimental allergic encephalomyelitis in guinea pigs, but makes them resistant against the effects of subsequent administration of the encephalitogenic mixture of adult-rabbit brain and spinal cord with the adjuvant.

The adjuvant used consisted of 1/3 lanolin, 2/3 paraffin oil by volume, with 5 mgm./ml. tubercle bacilli of the human type killed by autoclaving. The adjuvant was mixed in a blendor with a 50 per cent homogeneous cerebrum suspension in distilled water with 1 per cent phenol in a ratio of 1 : 1.

In group 1 fifty-two guinea pigs (each 300–350 gm. in weight) were injected subcutaneously every other day for a period of ten days with 0·2 ml. of one-day-old rabbit brain together with the adjuvant.

In group 2 forty-two guinea pigs were similarly injected with a mixture of the adjuvant and the brain of rabbit embryos extracted from the uterus of pregnant rabbits 5–10 days prior to birth.

No symptom of experimental allergic encephalomyelitis was observed in these animals over a period of six weeks.

At the end of this period guinea pigs of both groups and twenty-eight controls were treated every other day for ten days with 0·2-ml. challenge doses of a mixture of the brain and spinal cord of adult rabbits with the adjuvant (encephalitogenic mixture). In the control group typical experimental allergic encephalomyelitis developed in 21 of the 28 guinea pigs, that is to say, in 75 per cent. Out of 52 guinea pigs of group 1, experimental allergic encephalomyelitis developed in only 10 (19 per cent), and in only 6 (14 per cent) of the 42 animals of group 2.

Concurrently, five challenge injections of the encephalitogenic mixture were administered to 17 guinea pigs which had previously contracted experimental allergic encephalomyelitis in different experiments and had completely recovered 1–1½ months previously. Encephalomyelitis did not re-develop in any of these animals. Such complete resistance as this, when compared with the controls, in 75 per cent of which typical allergic encephalomyelitis occurred, indicates conclusively that these animals had acquired immunity against experimental allergic encephalomyelitis. Similar results were obtained when the experiments were repeated.

It appears from experiments to be described next that acquired resistance against allergic encephalomyelitis does not immediately follow administration of the mixture of the brain of embryo or new-born rabbits with the adjuvant. Thirty-two guinea pigs were injected five times (0·2 ml. administered every other day) with the mixture of embryonic rabbit brain with the adjuvant. Starting two days after the last injection, these animals, as well as thirty

control guinea pigs, were given five challenge injections each of 0·2 ml. of encephalitogenic mixture administered every other day. Allergic encephalomyelitis developed in thirteen animals in the experimental group, and in seventeen of the control group.

The existence of acquired resistance to experimental allergic encephalomyelitis demonstrated by these experiments is at variance with the widely accepted opinion that the encephalomyelitis is caused by anticerebral antibodies: and it may be suggested that the experimental allergic encephalomyelitis is a process *sui generis*. Further inquiry is necessary to determine the duration of acquired resistance.

Our evidence may contribute to the comprehension of the complex wave-like course of the demyelinizing diseases of the nervous system in man. These experiments suggest that the acquired resistance develops not only in animals surviving experimental allergic encephalomyelitis but may also be induced by the brain substance of embryo and new-born rabbits which lack any encephalitogenic activity.

It seems legitimate, therefore, to test the therapeutic capacity of such brain substances, either with adjuvants or without them, in demyelinizing diseases in human beings.

Our assumption is that experimental allergic encephalomyelitis and the resistance acquired against it are elicited by different factors. The adult brain contains two factors, of which one is responsible for the development of the encephalomyelitis and the other for the development of acquired resistance against it. The brain of embryo and of one-day-old rabbits contains only the latter factor.

It is the purpose of the forthcoming studies to produce purified fractions of the brain possessing the capacity to induce acquired resistance against experimental allergic encephalomyelitis and to elucidate the mechanism of this resistance. We suggest a close relationship between the acquired resistance to the experimental allergic encephalomyelitis and enhancing phenomenon in the homo–hetero transplantation of tumours in animals pre-treated with lyophilized tissue.

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Erythrophagocytosis in Cancer-bearing and Lymphoma-bearing Mice

In addition to the phenomena of agglutination and hæmolysis[1] of red cells in saline extracts of the spontaneous tumours of *C3H* mice, there is a third phenomenon, perhaps related to the first two because it also is evidence of red cell injury, which is observed in *AKR* and *C*58 strains of mice (both are usually referred to as leukæmic strains, but the *AKR* strain is better classified as a variety of lymphoma). This third phenomenon is erythrophagocytosis in the enlarged spleens.

In the *C3H* mice the tumours (mammary carcinomas) can be divided into black or red vascular or white non-vascular tumours; sometimes one tumour has areas of each kind. The black colour is the result of hæmolysis and probably capillary cytolysis; sections show masses of hæmolysed red cells lying in structureless pools. The red colour is extravasation of more or less intact red cells; erythrophagocytosis is usually observed, the phagocyte being either a macrophage or a tumour cell. An agglutinin and a lysin can be extracted with saline from both black and red tumours. In the white tumours there is little evidence of red cells being present, and erythrophagocytosis was not observed; an agglutinin and a lysin, however, can be extracted with saline. In no case was erythrophagocytosis observed in the spleen, regardless of the colour of the tumour and regardless of the enlargement of the spleen (3 to 4 times normal); this also applies to the *DBA*$_2$ and the *A*/Heston strains. The spleens of the tumour-bearing mice showed hæmosiderosis, the hæmosiderin granules being localized almost exclusively in macrophages, some of which were laden with them. The presence of so much hæmosiderin is presumptive evidence of a hæmolytic process, probably in the tumour. Direct Coombs tests and elution techniques demonstrated antibodies, or substances acting like antibodies in their ability to agglutinate test cells, in many tumour-bearers with moderate-sized tumours, but they were never obtained from the red cells of males or tumour-free females[2].

*C*58 mice showing no signs of leukæmia showed no erythrophagocytosis in the normal-sized spleens. If the mice had leukæmic glands (the peripheral blood of these animals is usually aleukæmic), conspicuous erythrophagocytosis was always found in the enlarged spleens, red cells being ingested by macrophages. In two cases a lysin was obtained from the lymph nodes; elution studies were carried out, but without success.

No erythrophagocytosis was found in the spleens of normal *AKR* mice, but in mice with lymphomatous glands and enlarged spleens there was always erythrophagocytosis in the spleen, and in one case in the liver. No attempts have yet been made to extract an agglutinin or a lysin from the lymph nodes, nor have elution studies yet been done.

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Assay of Erythropoietin in Bone Marrow Suspensions

Recently the presence of a substance capable of stimulating erythropoiesis (erythropoietin) in the peripheral blood of man[1] and anæmic animals[2] has been demonstrated repeatedly by a variety of assay methods[2–4]. Except for the few techniques which utilize the normal animal for assay purposes, all the current methods employ animals altered in such a way as to increase sensitivity to the test substance. Despite theoretical objections raised to the use of non-physiological preparations, such as the hypophysectomized or starved animal, in an assay, the results have been found reliable when iron-59 incorporation into the erythrocyte or reticulocytosis is chosen as the measure of erythropoietic activity[5].

A recently developed hæmatological study method is the measurement of iron-59 incorporation by human bone marrow cultures (Thorup, A., personal communi-

Table 1. Assay of Anæmic Rat Serum

Incubation time (hr.)	Anæmic serum (per cent)	Normal serum (per cent)	Radioactivity in cells (net c.p.m.)
1/3	0	31·8	119
	10·6	21·2	194
	21·2	10·6	185
	31·8	0	169
2	0	31·8	365
	10·6	21·2	604
	21·2	10·6	687
	31·8	0	859
24	0	31·8	433
	10·6	21·2	943
	21·2	10·6	1,355
	31·8	0	1,594

cation). The practical objections to current erythropoietin assay methods—expense in time, animals, and test material—can largely be obviated by using the incorporation of iron-59 into rat bone marrow cells in suspension.

Bone marrow is taken from the femora and tibiæ of an adult rat made anæmic by bleeding 4–6 days earlier. The marrow is suspended in a mixture of 2/3 Eagle's basal medium[7] and 1/3 serum, either normal or anæmic, to which a small amount of iron-59 has been added as ferric chloride. The nucleated cell count is adjusted to 10–15,000 cells per mm.^{3}, and 2-ml. aliquots are distributed into 10 mm. × 75 mm. siliconed test-tubes. At the start and at intervals following incubation at 37° C., control and test aliquots are taken for analysis. The cells are separated by centrifugation, washed with normal saline, re-suspended, and radioactivity is measured in a well-type scintillation counter.

The presence of 1/3 anæmic serum in the incubation mixture results in 2 hr. in at least a twofold increase in radioactivity in the cells over that found in a suspension treated similarly, but containing 1/3 normal serum. Using an aseptic technique and continuing the incubation for 24 hr., one can demonstrate up to a sevenfold increase in the incorporation of iron-59 into cells in the presence of anæmic serum as opposed to normal serum. The magnitude of the difference between control and test suspensions is a function of the amount of erythropoietin present, the activity of the marrow, and the time of incubation. Table 1 demonstrates the results of a typical assay procedure.

Work in progress may increase the sensitivity and extend the applicability of the method, but its potential usefulness in the present simple form recommends early reporting.

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Effect of Various Stilbene Compounds on the Phagocytic Activity of the Reticulo-Endothelial System

In his original observations on the influence of hormones on the appearance and activity of phagocytic cells in the endometrium, Nicol[1] reported that stimulation of these cells was only obtained following the administration of œstrogenic hormones. This work was later extended to include both natural and synthetic œstrogens[2–4] and the findings indicated that in both male and female animals œstrogens possess a strong stimulating influence on the reticulo-endothelial system which results in the appearance of large numbers of macrophages in the spleen, liver and lymph nodes, and the mobilization of these macrophages into the circulation. In the above researches the trypan blue method was used to assess the activity of the reticulo-endothelial phagocytes. These results have since been confirmed by the carbon method and it has been found that the strongest stimulant of the reticulo-endothelial system is diethyl stilbœstrol[5].

The following research was planned to ascertain whether or not variations from the structural formula of diethyl stilbœstrol (dihydroxy-diethyl stilbene) would alter the ability of the compound to stimulate the reticulo-endothelial phagocytes.

The present experiments were carried out on 80 male white mice (T.O. Swiss strain) of 20–30 gm. body-weight. Five of the animals were used for assessing the effect of each compound on the phagocytic activity of the reticulo-endothelial system, each animal receiving one subcutaneous injection of 0·5 mgm. of each substance in 0·05 ml. of arachis oil daily for 6 days. The phagocytic activity was then measured on the eighth day by the rate of disappearance of a known amount of carbon from the circulating blood[1], the procedure being as follows. Each animal was given one intravenous injection of carbon of particle size 250 A., the dose of the carbon being calculated on the basis of 16 mgm. per 100 gm. body-weight. Blood was then taken at short intervals during the first 60 min. following the injection, and the concentration of the carbon in each blood sample was measured by an absorptiometer. The logarithmic values of the absorptiometer readings lie along a straight line when plotted against time and the slope of the line has been taken as the measure of total body phagocytic activity or the phagocytic index, which is denoted in the present communication by the symbol K.

Twenty-five of the animals were used as controls. Each received one subcutaneous injection of 0·05 ml. arachis oil daily for six days and then showed an average phagocytic index or K value of 13, the carbon disappearing from the blood in about 100 min.

Table 1 shows the relative K values of various compounds related to diethyl stilbœstrol, together with their known levels of œstrogenicity. These results show that the strongest stimulants of the reticulo-endothelial phagocytes present the following features: (1) two *p*-hydroxyphenyl groups attached to adjacent carbon atoms (α and β); (2) unsaturation; (3) absence of hydrogen atoms at the α and β carbon atoms.

In the case of dihydroxy-diethyl stilbene the phagocytic index or K value is seen to be 105 and the carbon was found to disappear from the blood in about 12 min. compared with 100 min. in the controls. The results also show that when the above

Table 1. Effect of Various Stilbene Compounds on the Phagocytic Activity of the Reticulo-endothelial System

Compound used	Phagocytic index (*K* value)	Œstrogenic activity (R.U.)
4 : 4′ Dihydroxy-diethyl stilbene	105	0·001 mgm.
3 : 4′Di(*p*-hydroxyphenyl)-2 : 4-hexadiene	84	0·004 ,,
4 : 4′ Dihydroxy-α-ethyl-β phenyl stilbene	55	0·003 ,,
2 : 3 Di(*p*-hydroxyphenyl)2-hexene	37	0·001 ,,
Triphenyl-ethylene	25	10 ,,
α-(4-Hydroxyphenyl)-stilbene	24	0·25 ,,
2 : 2′ Dihydroxy-diethyl stilbene	20	1 ,,
4 : Hydroxydibenzyl	13	Negative
4 : 4′ Dihydroxystilbene	11	5 mgm.
4 : 4′ Dihydroxydibenzyl	11	10 ,,
Stilbene	11	25 ,,
Control values for 25 animals	13	

features are modified the compounds have little or no effect on phagocytosis or may even act as mild depressants. It should also be noted that the strongest stimulants all possess high œstrogenicity.

Further work is proceeding to find, if possible, a compound with a high level of phagocytic stimulation but without œstrogenicity.

We are indebted to Prof. D. H. Hey for help in the interpretation of the above results and to Sir Charles Dodds for generously supplying these compounds.

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Cytochromes of *Micrococcus lysodeikticus*

In an investigation of the difference spectra of bacterial cytochromes, Smith[1,2] found that *Micrococcus lysodeikticus*, strain 4698 A.T.C.C., possessed cytochromes *a* and *c*, but no absorption peak corresponding to cytochrome *b* was detected.

Working with *Micrococcus lysodeikticus*, strain N.C.T.C. 2665, derived from the original strain isolated by Fleming, we have found by direct visual spectroscopy that this organism contains cytochromes *a*, *b*, and *c*, the absorption maxima of the *a* and *c* components corresponding to those reported by Smith for strain 4698 A.T.C.C. Some concentration of the cytochrome *b* and partial separation of it from cytochromes *a* and *c* was effected by a method involving lysis of the cells with egg-white lysozyme, successive precipitations with ammonium sulphate and trichloracetic acid, and digestion of the residues with taka-diastase. The separation of cytochromes *a* and *c* from the *b* component was facilitated if a small quantity of ribonuclease was added with the lysozyme. The cytochrome *b* was found to remain associated with a particulate fraction which could be collected by centrifugation at 20,000*g*.

The concentrated cytochrome *b* preparations had associated with them considerable quantities of the yellow pigment of the organism, which has recently been reported to be a carotenoid[3]. This could be removed by extraction with *n*-butanol, but in the process there was some loss of cytochrome *b*. Moreover, the absorption band of the reduced cytochrome *b* after butanol treatment was less sharply defined than in the untreated preparations, a change which probably indicated a deleterious action of butanol on the cytochrome.

Spectrophotometric examination of the residues containing cytochrome *b* was carried out after reduction of the cytochrome with sodium dithionite and suspension of the material in glycerol to minimize light scattering. The absorption maximum of the cytochrome *b* component was at 563 mμ, which was the same as the position of the maximum seen in the whole-cell suspensions by visual spectroscopy.

It has been shown by Lightbown and Jackson[4] that 2-heptyl-4-hydroxyquinoline-N-oxide, an antagonist of streptomycin, inhibits electron transport in the cytochrome systems of certain bacteria and of heart muscle preparations. Visual spectroscopic experiments with whole-cell suspensions of *M. lysodeikticus* showed that addition of the antagonist, with succinate present as substrate, inhibited the oxidation of reduced cytochrome *b*, a result similar to that obtained with *Bacillus subtilis* and with heart muscle preparations[4]. The quinoline-N-oxide is effective as a streptomycin antagonist with *M. lysodeikticus*.

We wish to thank the Medical Research Council for a grant to assist this work, a detailed account of which will be published later.

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Isolation of *Salmonella infantis* from an Aborted Bovine Fœtus

Whereas abortion in cattle associated with *Brucella* or *Vibrio* infection is very common, it can, in some rare cases, also be caused by *Salmonella* species. The *Salmonella* strain most frequently held responsible for bovine abortion is *Salmonella dublin*; this strain has already been found in the Belgian Congo in a bovine fœtus. *Salmonella infantis*, a world-wide *Salmonella* type, which has already been isolated from man and several animal species, has not yet been recorded, so far as we can ascertain, as causing bovine abortion.

A five-month-old bovine fœtus was presented for bacteriological examination, and, as brucellosis is widely spread in native cattle in the Congo, it was at first suspected that it was infected with this pathological agent. The stomach contents and various parts of the internal organs were seeded on the usual mediums, including MacConkey agar. After a 24-hr. incubation period the Petri dishes were harvested and a pure culture of Gram-negative rods

was found; the typical behaviour of the culture on MacConkey agar makes a diagnosis of salmonellosis probable; this was confirmed by the rapid agglutination test with a polyvalent antisomatic *Salmonella* serum. Further incubation of media did not reveal any other bacterial micro-organism.

Several colonies of the MacConkey agar dishes were tested for their biochemical properties: these were always typical for *Salmonella* species. The serological examination of the strain revealed that it belonged to the O_1 group of the Kauffmann–White classification. The further serological diagnosis of *Salmonella infantis*, VI, VII : *r* : 1·5, was performed by Dr. van Oye in the Enterobacteriaceae Research Centre at Leopoldville; we wish to thank him for his valuable collaboration.

The detection of this *Salmonella* type, unusual for cattle in an aborted bovine fœtus, confirms the views of many workers that attention must be paid to the possible presence of *Salmonella* in all abortion cases of cattle and other domestic animals, in order to assess their importance in animal husbandry.

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Alcaligenes haemolysans

In 1936, Henriksen[1] isolated a Gram-negative rod from the human respiratory tract. This bacillus hæmolysed rabbit blood and was called *Bacterium haemolysans*. In 1957 a Gram-negative cocco-bacillus (now called 1092 of the National Collection of Dairy Organisms) was isolated from a blood agar plate of a swab of a cow's teat. This culture was hæmolytic and on an ox-blood agar plate the colonies, on superficial examination, might be confused with those of *Staphylococcus aureus*, because the hæmolysis resembled that produced by β-toxin.

Fortunately, one of Henriksen's original cultures was preserved in the National Collection of Type Cultures (*NCTC* 5043), but was called *Alcaligenes haemolysans*.

A comparison was made between the new isolate, Henriksen's culture, two strains of *Alcaligenes faecalis*, *NCTC* 8092 and *NCIB* 8156, and two strains of *Alcaligenes viscosus*, *NCDO* 494 and 715. Besides some of the usual tests for comparing bacterial cultures it was thought that paper chromatography, as suggested by Mattick *et al.*[2], might be useful, and might be of special value for organisms like those of the genus *Alcaligenes*, which gives many negative reactions with the normally accepted tests. Chromatography of acetic acid extracts from bacteria grown under standard conditions give reproducible characteristic patterns. Cheeseman *et al.*[3] demonstrated the reproducibility obtained from various strains of *Lactobacillus casei* and *Lactobacillus plantarum*, and were able to use the patterns to identify members of the two species.

The results with *Alcaligenes haemolysans* can be divided into two parts, those from paper chromatography (which will be discussed later) and those from the other tests; the latter are given in Table 1.

The two hæmolytic strains differ from each other because *NCDO* 1092 does not liquefy gelatin, while *NCTC* 5043 does. The property of gelatin liquefaction was assessed by two methods. The cultures were inoculated into nutrient gelatin stabs and incubated at 22° C. for 6 weeks, and the cultures were also streaked on Petri plates poured with nutrient agar containing 0·4 per cent gelatin. After five days incubation at 32° C. the plates were flooded with mercuric chloride solution. Otherwise the two hæmolytic strains appeared similar even to producing the same type of hæmolysis. The results given in Table 1 are few and it is not possible to say from them if the cultures are of the same species; however, the similarities are such that it is felt, at present, that they are closely related organisms. They are distinguished on morphology and hæmolysis from *Alcaligenes faecalis* and on hæmolysis and reaction in litmus milk from *Alcaligenes viscosus*.

Cultures *NCTC* 5043, *NCDO* 1092, *NCDO* 868 and *NCTC* 8092 were examined using the experimental methods for chromatography described by Mattick *et al.*[2]. It was necessary to harvest twice the quantity of organisms in order to obtain suitable chromatograms. Other material in the extract, which interfered with the running of the chromatograms, was removed by absorbing the amino-compounds on to ion exchange resin (Dowex 50 × 4, H^+ form). The desired compounds were then eluted with dilute ammonia. The cultures were grown in yeast dextrose broth at 30° C. and shaken to maintain aerobic conditions. Samples were taken at 16, 24 and 40 hr. Fig. 1 shows the patterns obtained for the 24-hr. culture

Table 1

	Alcaligenes haemolysans		*Alcaligenes faecalis*		*Alcaligenes viscosus*	
	NCDO 1092	*NCTC* 5043	*NCIB* 8156	*NCTC* 8092	*NCDO* 494	*NCDO* 715
Gram stain	±	±	—	—	—	—
Morphology	Cocco-bacillus in clusters	Cocco-bacillus in clusters	Rod	Long thin rods in chains	Cocco-bacillus in pairs	Cocco-bacillus in chains
Catalase production	+	+	+	+	+	+
Hæmolysis:						
Horse blood	Partial	Narrow zone of hæmolysis and wider zone partial	·	·	·	·
Ox blood	Partial	β	—	—	—	—
Rabbit blood	β	β	·	·	·	·
Gelatin liquefaction	—	+	—	—	—	—
Methyl red test	—	—	—	—	—	—
Voges Proskaur test	—	—	—	—	—	—
Utilization of citrate	+	+	+	+	+	+
Gas in McConkey broth	—	—	—	—	—	—
Litmus milk reaction	Slight reduction	Alkaline	Alkaline	Alkaline	Alkaline, viscous	Alkaline, viscous
Acid production in glucose peptone water	—	—	—	—	—	—
Motility	—	—	+	+	—	—

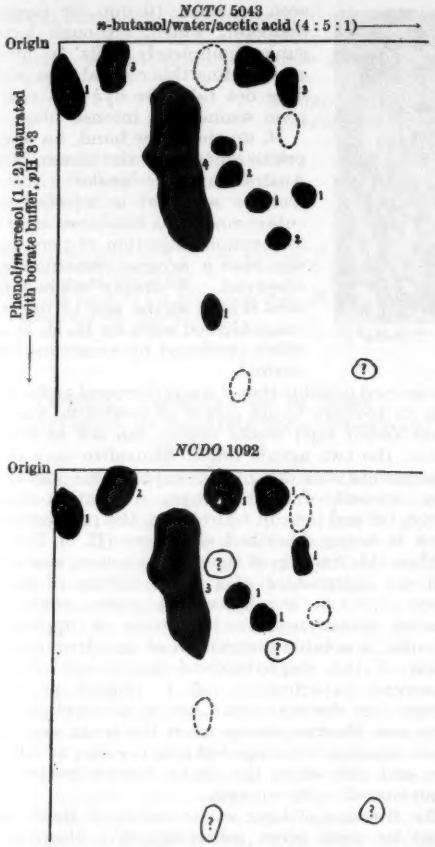

Fig. 1. Ninhydrin-positive pattern obtained by two-dimensional paper chromatography of acetic acid extracts of 24-hr. cultures of *NCTC* 5043 and *NCDO* 1092. The number to the right of each spot indicates the relative colour intensity. The spots with interrogation marks indicate a faint reaction. The broken circles indicate the spots that are absent in one extract but which are present in the other

of *NCDO* 1092 and *NCTC* 5043. Twenty-one ninhydrin-positive regions were obtained; the individual patterns were characteristic for each of the cultures examined. It would, however, be necessary to investigate a large number of organisms from this genus before the significance of these patterns as a means of strain and/or species differentiation could be assessed. However, the results of this limited investigation have indicated that cultures *NCDO* 1092 and *NCTC* 5043 are not the same strain, and have also demonstrated the possible use of this technique with this group of organisms.

We wish to thank Mr. F. K. Neave for bringing the culture of *Alcaligenes haemolysans NCDO* 1092 to our notice.

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An Attempt to adapt Explanted Tissues to an Anticonvulsant ('Trimedal') and to Phenobarbital

IT has been shown repeatedly that explanted animal cells are able to adapt themselves to several kinds of substances, some of which are used in medical practice and some of general biological interest (adaptation and addiction to opium alkaloids[1] and ethyl alcohol[2,3], adaptation to salvarsan[4], to mercuric salts, dinitrophenol and atropin[5]). Adaptation and addiction to other substances are known from *in vivo* experiments and from clinical practice. Adaptation and abstinence phenomena have been reported in animals[6] and man[7] given barbiturates for a long time, but explanted tissues of rats given barbiturates *in vivo* over a prolonged period did not tolerate a toxic dose of the drug[8]. No reports about direct adaptation of explanted tissue cells to barbiturates or anticonvulsants are known to us.

We tried to adapt chicken embryonic heart fibroblasts to 'Trimedal' (3,5,5-trimethyl-oxazolidine 2,4 dione), an anticonvulsant used as a therapeutic in epilepsy. Fragments from the heart of 12-day-old chicken embryos were explanted into hanging drops of a medium consisting of two parts of a harmless concentration of the drug (0·01 per cent, final concentration in the medium, 0·005 per cent), 1 part of native chicken embryonic extract and 1 part of hen plasma. Control cultures had the same medium without the drug. After 72 hr. of incubation at 38° C. both experimental and control cultures were excised and transferred to a new medium containing 6 per cent 'Trimedal' in distilled water (final concentration 3 per cent), a dose near Pomerat's minimal inhibition dose[9]. In this concentration of the drug, the growth of cultures not pretreated with the drug is either completely inhibited, or only a few much degenerated cells emigrate from the explanted fragment; only exceptionally is a narrow growth-zone formed.

Fifteen experimental series were carried out with 'Trimedal'. In each series, five experimental and five control cultures were prepared from the same embryonic chicken heart. All cultures derived from the same individual behaved approximately in the same way in the experiment or in the control, so that the observed variations between individual series can be explained by variation of the donor individuals.

In nine of the fifteen series, a marked adaptation of cultures pretreated with low concentration of 'Trimedal' was observed: in the control series only some much degenerated cells appeared; in the pretreated cultures a continuous growth-zone was formed. In another two sets the difference between pretreated and control cultures was even more marked: no growth of the control explants was observed, whereas in the pretreated cultures a rather abundant growth-zone appeared (Fig. 1*a*, *b*). In four sets only was no difference in the growth of the pretreated and control cultures observed, some degenerated cells emigrating in both instances.

The 'adapted' cells from the pretreated cultures are nevertheless far from normal; their protoplasm shows a foamy vacuolization and in most cells a big juxtanuclear vacuole appears (Fig. 1*c*). Only two transfers of these cells in the same concentration of 'Trimedal' were possible, before degeneration ended in death of the cultures.

Analogous experiments were carried out with phenobarbital sodium, but with different results.

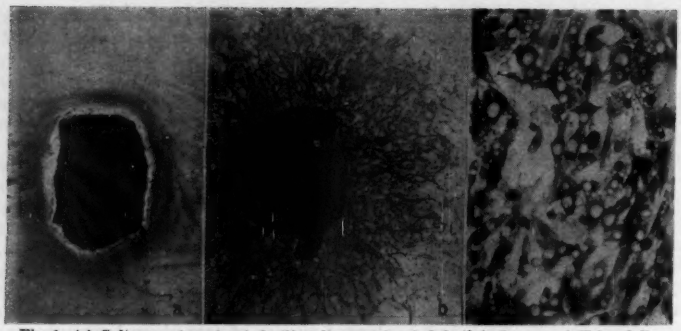

Fig. 1. (*a*) Culture not pretreated, (*b*) culture pretreated, both in 3 per cent 'Trimedal'; (*c*) cells of the pretreated culture at higher magnification

Here the high concentration used was 1 per cent of the drug in Hanks's solution, isosmolar (0·5 per cent final concentration); higher concentrations are not soluble at a physiological *p*H. In the pretreated as well as in the control cultures, a marked inhibition of growth and vacuolar degeneration of the cells appeared.

It may be that adaptation to phenobarbital could be attained under more suitable conditions, for example, prolonged pretreatment. Experiments with longer cultivation of tissues in low concentrations of these and other drugs, as well as in gradually increasing concentrations, are in progress, and the necessity of expressing the adaptation phenomenon in quantitative terms is being considered.

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Antagonism between the Actions of Staphylococcal Toxin and Tiger Snake Venom

Early work on the mode of action of staphylococcal toxin showed that in rabbits it constricts the pulmonary and coronary blood vessels[1]. More recently it was found that vascular spasm and alteration in capillary permeability are factors largely responsible for such characteristic toxic lesions as renal cortical necrosis and dermonecrosis in rabbits[2]. Such effects are readily demonstrated when staphylococcal alpha toxin is injected subcutaneously into the mouse and the animal is killed after an appropriate interval, if a solution of the dye, pontamine sky blue, has been injected intravenously a few minutes beforehand. In the centre of the lesion is seen an area, 10 mm. or more in diameter, which, although hyperæmic, completely fails to stain; surrounding this central area which does not take the dye is a narrow zone stained an intense blue.

If, on the other hand, an appropriate amount of the venom of the Australian tiger snake (*Notechis scutatus scutatus*) is injected subcutaneously into mice soon after the intravenous injection of pontamine sky blue a reverse phenomenon is observed. A deeply stained blue area is seen at the site of injection (unpublished work by H. M. D.), an effect produced by numerous lethal toxins[3].

It seemed possible that if staphylococcal alpha toxin owes its toxicity to its power of producing vascular spasm and if tiger snake venom can act as a vasodilator, the two agents might neutralize each other. Experiments were designed to explore this possibility, using, instead of crude venom, a fraction rich in hæmolysin and poor in neurotoxin, the preparation of which is being described elsewhere (H. M. D.).

When this fraction of tiger snake venom was mixed with the supernatant of a broth culture of staphylococci rich in staphylococcal alpha toxin and injected subcutaneously into mice in appropriate amounts, a notable diminution of the dermonecrotic action of the staphylococcal toxin was observed in several experiments. A significant protection against this dermonecrotic action of staphylococcal toxin was likewise shown when the toxin and snake venom fraction were injected into the skin at different sites and also when the snake venom fraction was administered intravenously.

The fraction of tiger snake venom is itself highly lethal to mice given intravenously. However, in experiments using in all more than one thousand mice, it has been shown repeatedly that if one-sixth of the *LD*50 of the venom fraction is given intravenously, either mixed with staphylococcal toxin or separately up to ten minutes before injection of the toxin, significant protection against the lethal effect of the toxin results. Protection has been evident against amounts of toxin varying from one *LD*50 to a certainly lethal dose. The results of six consecutive experiments are shown in Table 1. Further, no definite protection against death has been obtained when the toxin has been administered before the snake venom fraction.

The results of these experiments suggest that the protective action of the venom fraction may be due to its prior attachment to sites on susceptible cells which otherwise would be available to staphylococcal toxin.

Table 1. Protection afforded by Tiger Snake Venom Fraction against Intravenous Challenge with Staphylococcal Alpha Toxin in Mice in Six Consecutive Tests

Test No.	Survivors after seven days		
	Toxin	Toxin and venom fraction	Administration
1	9/18	18/18	Separately
2	9/15	15/15	Together
3	6/15	15/15	,,
4	1/20	15/18	,,
5	5/20	17/20	,,
6	9/18	17/18	,,

Work is continuing in an attempt to elucidate more precisely the nature of the protective action which tiger snake venom exhibits against staphylococcal alpha toxin.

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Organic Composition of Bone: Localization of Isocitric Dehydrogenase in Femurs

THE original observation of Dickens[1] that calcified tissues contain the majority of the body's citric acid has raised the question of the mechanism by which this occurs. Currently, hypotheses to explain bone citrate levels are based on the findings of Dixon and Perkins[2], who observed relatively little isocitric dehydrogenase in rabbit femurs. We felt that these values[2] might be minimal, since manganese ions and triphosphopyridine nucleotide were not used as supplements. Furthermore, citric, rather than isocitric, acid was used as the substrate in the assay system. In the present work, tissues were assayed[3] for isocitric dehydrogenase activity using a spectrophotometric method. Extracts of soft tissues (weight × 5 of 0·1 *M tris*, *p*H 7·4; 15 min. at 1,100*g*) from exsanguinated animals were assayed. The femurs were frozen in 'dry ice', cleaned of adhering muscle, connective tissue and periosteum, then sawn into five transverse sections. The marrow was removed from the shaft marrow space. Each section was crushed in 'dry ice' to an eight mesh. 1-gm. samples were extracted in the refrigerator with 2·0 ml. of 0·1 *M tris*, *p*H 7·4 for 4 hr., then centrifuged. The extracts were assayed and the rate of reaction was determined from the linear portion of the reaction curve using the molecular extinction coefficient[4] for reduced triphosphopyridine nucleotide of 6·22 × 10^6 cm.^{2}/mole.

The values presented in Table 1 indicate that isocitric dehydrogenase activity many times greater than that previously reported was found in all sections of the femurs, with highest activity in those areas containing spongy bone. Contrary to Dixon and Perkins[2], who failed to demonstrate activity in bone marrow, our data show considerable isocitric dehydrogenase activity in this tissue. Since trabeculated bone of the femur is surrounded by marrow elements, which were not separable from the calcified areas, the observed enzyme activities are partly a reflexion of the marrow enzyme.

Table 1. ISOCITRIC DEHYDROGENASE ACTIVITY*

Tissue	Growing dogs (approx. 9 months old)		Growing rabbits (8–9 weeks old)	
	Act./gm.	Act./mgm. protein	Act./gm.	Act./mgm. protein
Kidney	418	5·90	742	8·96
Liver	578	7·72	835	10·14
Submaxillary	158	3·25	325	3·07
Femur†, Sect. 1	26	1·36	76	4·18
,, ,, 2	23	1·38	43	4·65
,, ,, 3	5	1·43	9	3·34
,, ,, 4	19	1·44	16	3·77
,, ,, 5	24	1·41	58	4·17
Marrow	48	1·57	115	4·08

* μMoles triphosphopyridine nucleotide reduced/hr. expressed either as per gm. fresh tissue or per mgm. protein. Values are means of at least four separate preparations.
† Section 1, proximal head but not including the lesser trochanter; section 2, extended distally to the marrow space; section 3, midshaft (compact bone); section 4, midshaft to approximately the midpoint of the popliteal surface; section 5, remainder of the femur.

In view of the above findings of considerable isocitric dehydrogenase in the head of the femur, it would be of interest to investigate factors which have been shown to influence the apoenzyme or triphosphopyridine nucleotide-levels in other tissues (that is, vitamin D[5], œstradiol[6], etc.).

The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the U.S. naval service at large.

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Importance of the Synthesis of Acidic Polysaccharide for Wound Healing

Weiss and Matoltsy[1] have reported that wounds in chick embryos fail to exhibit healing prior to about the twelfth day of incubation, but that by the sixteenth day of incubation the mechanisms of healing appeared to be fully developed. This observation appears to have additional significance in relation to some of our work on the synthesis of sulphated polysaccharides in the tissues of embryos and young animals.

We have presented experimental evidence in support of our suggestion[2–4] that the healing of open wounds is dependent upon the ability of the tissues to synthesize, at the site of injury, certain sulphated mucopolysaccharides. Administration of cortisone elicits a reduction in the synthesis of acid mucopolysaccharides, possibly by interfering with hexosamine synthesis in the tissues[5], and concomitant with this inhibition there is a failure of wounds to heal[6]. It was shown also that there is a reduction in the synthesis of sulphated polysaccharides in the tissues of the scorbutic guinea pig[5]. Studies on wound healing in normal animals, in animals treated with cortisone, and in scorbutic guinea pigs indicated a relationship between fibroblastic activity and the synthesis of sulphated mucopolysaccharide. Vascularization is partially responsible for the increased synthesis in wound tissue, but the acidic sulphated polysaccharide observed in the metachromatically stained ground-substance of granulation tissue appears to have been secreted by, or to be associated with, the fibroblasts and mast cells.

In order to determine the relationship between developmental stages and the capacity of chick tissues to synthesize sulphated mucopolysaccharides, skeletal

muscle and skin tissue slices were maintained *in vitro* in a medium containing sodium sulphate-^{35}S by a method previously described[2]. The labelled tissues were mixed with unlabelled bovine nasal cartilage as carrier material, and the mucopolysaccharides extracted and purified by the method of Partridge[7]. Treatment of the labelled sulphated polysaccharides with testicular hyaluronidase showed that those from soft tissues are more resistant to depolymerization by this enzyme than is chondroitin sulphuric acid from cartilage[8].

The relationship between developmental stage and the capacity of tissue to synthesize sulphated polysaccharides is shown in Table 1.

Table 1. Relationship between Developmental Stage or Age and the Capacity of Chick Skeletal Muscle Tissue Slices to Synthesize Sulphated Mucopolysaccharide *in vitro*

Days from beginning of incubation of fertile eggs	Sulphated mucopolysaccharide synthesized (μgm./100 mgm. wet tissue)	
	Bound in tissue	Found in medium and washings
11	3·6	—
12	4·0	—
15	6·7	2·5
17	5·9	2·5
18	4·0	2·0
21	1·4	1·0
27*	0·5	0·5
66†	6·8	2·5

* Chick, 6 days *ex ovo*. † Edge of healing; muscle wound

An *in vivo* study was conducted as follows. Thirty white Leghorn chicks, two weeks of age, were divided into two groups of fifteen chicks each. Chicks in the first group received intramuscular injections of 25 mgm. cortisone per kgm. body-weight daily for two weeks. Those in the second group were injected daily with an equivalent volume of saline. After one week all chickens in both groups were wounded by aseptic removal of samples of tissue from the thigh and the flight muscles. On the second day after this, each chicken was injected with 10^7 counts of carrier-free sodium sulphate-^{35}S per kgm. body-weight. On the seventh day after the injury tissue samples were removed for histological examination and polysaccharide determination. There were no indications of fibroblastic activity, metachromasia or acidity in the wounds of the chickens treated with cortisone. Mucopolysaccharides were isolated[8] from tissue from the edges of the wounds and compared to those from the neighbouring uninjured tissue. The ratios of specific activities of sulphated polysaccharides for wound tissue/uninjured tissue were found to have a mean value of 1/1 for animals treated with cortisone and a value of 4/1 for the controls. These results indicated that there had been no increase in synthesis of sulphated polysaccharide in the non-healing wounds of the animals treated with cortisone, while a four-fold increase in synthesis had occurred in the edges of the wounds of the control animals. It appears to us that the newly synthesized acidic mucopolysaccharides are responsible for the lower *p*H observed in the tissue and fluids of healing wounds, and are partially responsible for the chemotactic or migratory stimulus exerted upon cells of the neighbouring vascular, epithelial, and connective tissues. It would appear that prior to the twelfth day of incubation chick embryos may be deficient i. either cells of the type or maturity required for the secretion of the particular sulphated polysaccharides characteristic of granulation tissue or in the enzyme systems responsible for the synthesis. The capacity to synthesize sulphated polysaccharides, though very low in uninjured adult tissues, is regained at the site of injury possibly because of infiltration by fibroblasts and other connective tissue cells which do possess this capacity.

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Interpretation of Nucleolar Inclusions

In the nucleolus there are frequently vacuolar inclusions and granulations. In rare cases, intranucleolar crystallites may also be seen. Recently, attention has been directed to a thread-like formation within the nucleolus, which has been called a 'nucleolonema'[1]. Similar structures appear in electron micrographs of osmium-fixed preparations[2], but they may not be entirely homologous to the structures seen under the ordinary microscope, since their relative sizes are different. Nucleolonematic structures had previously been observed by Cajal in 1893, but he later concluded that they were artefacts[1]. According to Estable and Sotelo[1], the nucleolonema should pass to daughter cells in mitosis and meiosis with the chromosomes, on the surfaces of which it disposes itself in prophase, while the remainder of the nucleolus disintegrates. This interpretation could be extended so far as to suggest that the nucleolonema is the real genetic material of the nucleus and that the chromosomes are perhaps only its bearers in mitosis.

While vacuolar and granular inclusions are easily seen in the nucleolus in life, the reality of the nucleolonema has been questioned by some authors[3]. In some cases it is the nucleolar zones of the nucleolar chromosomes which give the appearance of an intranucleolar filament[4]. In other cases, namely snail oocytes, the formation of granulations and vacuoles may give rise to nucleolonematic structures by coalescence of the smaller granulations or vacuoles[5]. In poor conditions, the nucleoli may decompose into granulations and thread-like bodies, with a nucleolonematic aspect. Similar appearances may be brought about by treatment with chemicals, notably adenosine and other nucleotides[4,6].

However, nucleolonemata which may co-exist with the filaments of the nucleolar zones and with vacuoles can easily be demonstrated in many nuclei by a modification of Baker's test for lipins[7]. With prolonged differentiation the lake of hæmatoxylin–chromium, which first stains the whole nucleolus

intense black, may be dissolved. Between the extremes of complete staining and complete destaining, nucleolonematic structures appear. In root-tip meristems (for example, *Vicia faba*, *Allium cepa*, *Encephalartos*) every nucleolus shows by this method a nucleolonema, with turns and twists. On the other hand, snail oocytes (*Helix aspersa*, *Cepaea nemoralis*) and salivary gland cells of *Chironomus* generally do not show, or show only rarely, a typical nucleolonema. Instead, snail oocytes usually show zones of more intense staining in relation to vacuoles.

A specific test for masked lipids[5] with sudan black *B* and demasking of lipid complexes does not give appearances similar to those obtained with the lake of hæmatoxylin–chromium. With the masked lipids test, only a narrow zone next to vacuoles may show a nucleolonematic aspect, which is not distinguishable from the coalescence of fine granulations or small vacuoles. Nucleolonematic structures are also seen after using fixatives that dissolve lipids. It seems, therefore, that the nucleolonematic region is not markedly more rich in these compounds than the remainder of the nucleolus. As applied here, with excessive differentiation, Baker's[7] modification of the Smith–Dietrich test probably does not demonstrate lipins but only serves to indicate a different power of retention for the lake of hæmatoxylin–chromium. This must be due to characteristic physical rather than chemical properties, since similar results are also obtained by iron alum–ferricyanide–pyrogallol staining[1], which functions by a physical method. The differential retention may be due to a kind of ultra-filtration effect, caused by greater density in colloidal compounds, or to the availability of interfaces capable of adsorbing the lake, or possibly to both. This situation, the appearance of vacuoles and granulations in the nucleolus, and the similarity of these phenomena with secretion and elaborations in the cytoplasm and Golgi bodies, may be explained by the existence in the nucleolus of a capacity for phase differentiation, which is an index of nucleolar activity. A partial separation of phases gives rise to interfaces, to vacuoles; and by appropriate staining, nucleolonematic structures become visible. This is an epigenetic explanation of nucleolar structure, as contrasted with a preformationist hypothesis where nucleolonema would be a permanent structure of the nucleus. According to my explanation, the nucleolonema is of the same rank as the vacuoles or other nucleolar differentiations: it is not a permanent structure in the nucleus nor does it necessarily exist in every nucleolus at all times.

A more detailed account of this work will be published elsewhere.

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Congenital Malformations in Children of Mothers Aged 42 and Over

In the heterogeneous group of congenital malformations, correlation with factors such as parental age are of etiological and epidemiological significance. Parental age has also a special relevance to the problem of gene mutation induced by ionizing radiation[1]. The average individual gonad dose received before and during the reproductive period varies greatly in the different populations of the world. Apart from radiation from atomic energy plants and nuclear weapons, this variation is due mainly to differences in natural background radiation and differences in the use of diagnostic X-rays.

Since some congenital malformations are due to fresh mutation it may be anticipated that the accumulated doses which have been received by older individuals cause a higher incidence of such conditions in their offspring. This problem, as well as the specific effect of advanced parental age *per se*, is a complex one. Parental age effects are known in some specific conditions, for example, mongolism and achondroplasia[2]. However, very few studies have been made in which the starting-point was a population of mothers of greater than average age[3,4]. Further, such data from different populations are necessary to make possible more detailed analyses.

From a total of 70,962 births at two obstetric wards in Stockholm and one in Upsala during 1946–55, we have selected all mothers of 42 or more years of age. They totalled 1,030, or 1·5 per cent of all mothers in the wards concerned. This group can be considered as a random sample, as in this region practically all births occur in obstetric clinics. We have studied the files of these 1,030 women. Observations on the children ceased when they left the obstetric ward after an average of one week.

It should be noted that all three clinics have a pediatric service. As there were nine twin and one triple births the total number of children was 1,041. We registered a total of 47 malformations, which gives an average risk of 4·5 per cent. The distribution of malformations is shown in Table 1. For comparison with the average incidence of congenital malformations in Sweden we have used the same diagnostic classification as in an earlier study by one of us[5]. Except for anencephaly all differences are statistically significant. Seven of the 47 malformed children died before or during delivery and six within one week after delivery. It was calculated that although the present sample of mothers constituted 1·5 per cent of the total, they contributed 5·1 per cent of the total of malformed children during the period.

Table 1

Classification	No. of cases	Percentage of total malformations	Malformations per 1,000 children	
			Mothers (42 and over)	Mothers (all ages)
Mongolism	22	46·8	21·1	0·45
Anencephaly	2	4·3	1·9	0·54
Gastro-intestinal	6	12·8	5·8	0·86
Bones, muscles, skin	10*	23·4	9·6	6·8
Cardio-vascular	7	12·8	6·7	1·1
Others	0	0	0	2·2
Total	47	100·1	45·1	13·4

* Five cases of congenital clubfoot.

Table 2

Maternal age	No. of children	Mongolism	Other malformations	Total malformations
42	433	5 1·2 per cent	11 2·5 per cent	16 3·7 per cent
43	279	5 1·8 per cent	5 1·8 per cent	10 3·6 per cent
over 43	329	12 3·6 per cent	9 2·7 per cent	21 6·4 per cent
Total	1,041	22 2·1 per cent	25 2·4 per cent	47 4·5 per cent

Table 2 shows the material divided into the age-groups 42, 43 and over 43. The differences are not statistically significant.

The risk of mongolism is outstanding. No less than twenty-two cases were observed, amounting to 2·1 per cent of all children.

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Cellular Basis for the Induction of Morphological Structures

Differentiation in a higher organism, be it plant or animal, always involves at some stage the development of different morphological entities from different parts of a group of superficially similar cells which are derived by division from a single cell. The group of cells is said to constitute a morphogenetic field. A new, but entirely speculative, interpretation of this phenomenon is proposed here which relies on an induction of polarity in division, and on changes in metabolic pattern in different parts of the cytoplasm with age. It has been shown with plant material that considerable changes in metabolic state may occur within a few hours, and it has been suggested that these are mediated through corresponding changes in the structure of the protein complex.

The interpretation is elaborated in terms of a model which involves the formation of a group of cells from a single parent cell. It is supposed that each cell in the lineage divides and always in the same plane.

The system begins with a hypothetical parent cell having horizontal walls of the same age which are designated 1 and 1 (see Fig. 1). It may be emphasized that the age of the wall is of no significance, but the wall carries against it or within it cytoplasm of a corresponding age, and it is this which is the important aspect. The parent cell divides, giving the situation of *A* in the diagram. A spindle is formed and in the plane of the equator a new wall marked 2 is deposited giving two cells *a* and *b*. The figure has been drawn to emphasize the fact that, with respect to each of the

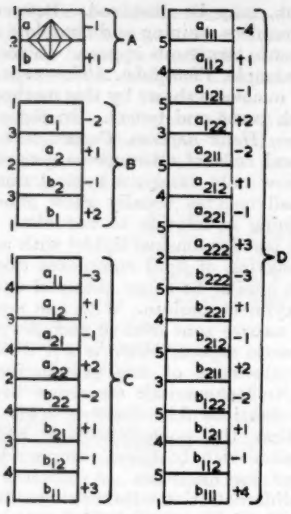

Fig. 1

cells that is being formed, the spindle dominates the structure of the cell to a greater extent at one end than it does at the other. Thus in the recently formed cell, one end has been derived from relatively undisturbed parent cytoplasm whereas the other has inherited the conditions created by the spindle. Metabolic conditions in spindle and in undisturbed cytoplasm are likely to be distinctively different. The interpretation relies on the possibility that uniformity throughout the cytoplasmic system is not established immediately division is complete. On the contrary, it is suggested that the difference persists and that development proceeds independently in the two ends of the cell. This development leads to changes in both ends. Both ends as they age traverse the same developmental sequence, but the two remain different since they start at different stages of the succession. Thus as a result of division a metabolic gradient is established (indicated by + 1 and − 1 to the right of Fig. 1, *A*). This gradient is the basis of polarity. From this it follows that polarity is a consequence of division and that every cell (at least in the embryonic system) is polar.

From *A* it is evident that when division is complete the gradients in the two cells are disposed in opposite directions (indicated by the positive sign with one and the negative sign with the other) and the two cells are in a sense mirror images of each other. Except with respect to this characteristic, the two cells (in this model system) are identical. With the next division in each cell a more extensive differentiation is introduced. Whatever the age of the cell, the characteristics of the spindle are likely to be constant; and therefore whatever the age of the cytoplasm in the zone in which the spindle is formed, this is likely to be returned to a basic ground-state. The consequence of this may be seen from *B*, which shows the position in the cells derived from *A*. At the end of this second division the cytoplasm on both sides of each wall marked 3 is in the ground state. Against the walls marked 1 and against that marked 2 the cytoplasm is older, and a gradient is established in each cell. The directions of the gradients alternate. It is significant, however, that whereas the cytoplasm against the walls marked 1 has persisted through two

division cycles, that on the two sides of the wall marked 2 is the product of only one cycle, and the gradient in a_1 and b_1 is therefore steeper than it is in a_2 and b_2. The steepness of the gradient in each case is shown by the values to the right of the diagram.

With the induction of further divisions the differences between different cells become greater, and when the whole group is considered a characteristic pattern of different types of cells becomes evident. *C* shows the position when a third and *D* the position when a fourth division has occurred. It may be noted that:

(1) The whole assemblage of cells in *D* clearly constitutes a morphogenetic field. The different cell-types are not disposed randomly and they are not distributed in an ascending or descending sequence. Particular cell-types are in characteristic and determinate positions with respect to others.

(2) In *D*, cells with particular gradients recur in different parts of the group. Some cells, however, are unique. There is only one, for example, that has the configuration of + 3 and only one that has that of + 4.

(3) Cells with sharply contrasted gradients are developed immediately adjacent to each other. If the cell having the structure of + 4 develops into a leaf primordium, the formal conditions for the development of the adjacent cell into an axillary bud are provided by the state of *D*, since the cell immediately above that with the structure of + 4 has the structure of − 1.

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Interference between Plant Viruses

Prior infection of a plant with a virus may prevent or interfere with the production of local lesions or systemic infection of a strain of the same virus[1]. This interference or cross-protection is used as a criterion for relating plant viruses. The experiments briefly reported here are part of a study on interference between serologically related viruses although serologically unrelated viruses were included to observe the specificity of the reaction. Interference occurred not only between the related but also between the apparently unrelated viruses.

Interference was quantitatively estimated by comparing the number of necrotic local lesions of the challenging virus on plants systemically infected with a related or an unrelated virus with lesions of the same virus on initially healthy plants. This system is commonly used in cross-protection experiments[1]. *Nicotiana tabacum* L. (var. White Burley) and *N. glutinosa* L. were the hosts and the interval between the two inoculations varied from 14 to 21 days. With each virus combination, ten infected and control plants were inoculated on three or four leaves and lesion counts were expressed as average number of lesions per 100 cm.² of leaf area. The systemic viruses were tobacco severe etch, a 'type' strain of cucumber mosaic, potato virus *Y* and potato virus *X* strains *AST*4, *AST*1 and *X*4 [2]. A 'type' strain and a masked strain of tobacco mosaic were also used with tobacco. The challenging viruses on tobacco were cabbage black ringspot, potato virus *X* strain *Br* [3], a ribgrass strain of tobacco mosaic and the *B*1 tobacco necrosis virus[4], and on *N. glutinosa* the challenging viruses were *Br* and the ribgrass and 'type' strains of tobacco mosaic.

Table 1. Interference between Systemic and Necrotic Lesion-forming Viruses in Tobacco

Systemic virus \ Necrotic virus	Cabbage black ringspot		Potato virus *X* strain *Br*	
	No. of lesions per 100 cm.²	Percentage of control	No. of lesions per 100 cm.²	Percentage of control
Virus *X* strain:				
*AST*1	8	11*	7	12*
*X*4	16	22*	43	72†
*AST*4	18	24*	60	100
Tobacco mosaic strain:				
Type	3	4*	51	85
Masked	14	19*	—	—
Potato virus *Y*	7	7*	162	270*
Tobacco severe etch	4	6*	112	45*
Cucumber mosaic	26	2*	10	14*

* Significant at $P = 0{\cdot}01$
† Significant at $P = 0{\cdot}05$

Table 1 gives typical results using tobacco as the host. In each of the following combinations on tobacco the number of challenging virus lesions were reduced to at least 50 per cent of the number on control plants (the systemic virus is indicated first in each case): tobacco severe etch and cabbage black ringspot, tobacco severe etch and tobacco necrosis, tobacco severe etch and potato virus *X*, potato virus *X* and cabbage black ringspot, potato virus *Y* and cabbage black ringspot, tobacco mosaic and cabbage black ringspot, cucumber mosaic and potato virus *X*, cucumber mosaic and tobacco mosaic, cucumber mosaic and cabbage black ringspot. The following combinations on *N. glutinosa* also resulted in at least a 50 per cent reduction in lesions: tobacco severe etch and tobacco mosaic, cucumber mosaic and tobacco mosaic. Many leaves, especially those showing symptoms of the first inoculation, showed no challenging virus lesions and no virus was recovered from such leaves. With many combinations interference was indicated not only by a reduction in lesion numbers but also by a change in the lesion type, usually a restriction in size compared with controls. The extent of interference appeared to be dependent on the particular host and virus strain used.

In comparative experiments with serologically related strains of virus *X* similar degrees of interference occurred. A significant increase in the number of lesions of the challenging virus occurred also on infected compared with healthy plants. This phenomenon was observed, for example, between potato virus *Y* and potato virus *X*.

Many factors such as age of plant, light intensity and host nutrition can influence the susceptibility of plants to viruses, and it is therefore not surprising that prior infection with a virus can also influence susceptibility. Despite some evidence to the contrary[5–7], most workers have concluded that interference occurs only between closely related plant viruses. One recognized exception is between tobacco severe etch and potato virus *Y*[8]. The results presented indicate, however, that non-specific interference occurs not only between viruses which have similar properties such a morphology, stability and method of transmission, for example, tobacco severe etch and cabbage black ringspot, potato virus *Y* and cabbage black ringspot, but also between viruses which appear quite distinct, such as tobacco mosaic and cabbage

black ringspot, tobacco severe etch and tobacco necrosis.

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Evidence from a Dwarf Pea Bioassay for Naturally Occurring Gibberellins in the Growing Plant

Substances with a biological activity similar to that of gibberellic acid have been shown to be present in extracts of seeds of several species of higher plants[1–3]. Radley[4] has published evidence for the presence of such substances in the growing plant, but the specificity of her bioassay method has been questioned[5]. No other direct evidence for the existence of gibberellin-like substances in the growing plant (as compared with the seed) has been published, although a considerable and growing body of indirect evidence is in favour of this concept[6,7]. It is the purpose of this communication to bring forward more definite direct evidence for the presence of gibberellin-like substances in the growing plant.

A method of bioassay has been developed based on the effects of gibberellic acid on internode extension of dwarf pea seedlings[8]. Pea seedlings (var. Meteor) are grown in upturned bottles from which the bases have been removed. Each bottle, 16 cm. tall and 8 cm. wide, is almost filled with perlite, retained by a plug of cotton wool in the neck. The bottles stand in metal troughs containing about 2 in. of water. This ensures a continuous and even supply of water to all the plants. The peas are allowed to imbibe for 5–6 hr., abnormal ones discarded and the rest sown, seven to a pot, and covered with a layer of coarse gravel. This prevents the cotyledons being lifted out of the perlite. The plants are grown in light from natural and red fluorescent lamps (intensity about 600 ft. candles, daylength 12 hr.) at a day temperature of 22° C. and a night temperature of 18° C. After about 10 days, when the fourth internodes are elongating, the plants are labelled individually and the interval (*A*) between the third and fifth nodes (counting the cotyledonary node as node 1) measured. Atypical plants are discarded and the pots randomized. A measured drop (4 µl.) of the solution to be assayed is placed in the axil of the scale-like leaf subtending the third node of each plant. 15 replicates are used for each treatment. Between-container variance was found in early tests to be not significant. Six days after treatment the length (*B*) between the third and sixth nodes is measured and the logarithm of the percentage increment over controls is plotted against log (weight gibberellic acid).

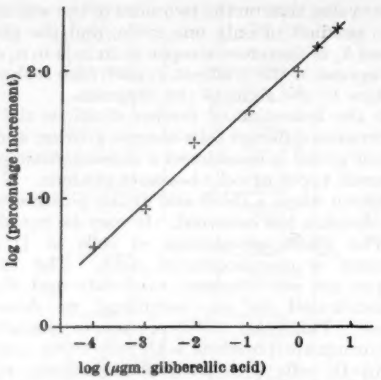

Fig. 1. Bioassay curve for gibberellic acid. Increment calculated as $\log_{10}\left[\frac{100\{(B-A)_{\text{treated}} - (B-A)_{\text{control}}\}}{(B-A)_{\text{control}}}\right]$

In one of a series of trial experiments 0·001 µgm. of the acid (kindly supplied by Imperial Chemical Industries, Ltd.) gave a response which was significant at less than 5 per cent (*t* test). Fig. 1, compiled from the means of several experiments, shows that the plot of log per cent increment against log weight gibberellic acid is linear over the range 0·0001 to 5 µgm.

For extraction, greenhouse-grown peas of a tall variety, Telephone, 21 days old were cut off above the cotyledons. 710 gm. of shoots thus obtained were frozen in solid carbon dioxide and crushed to a coarse powder. This was stirred into 2·5 l. of water saturated with ethyl acetate and allowed to stand overnight in the cold. The extract was filtered and shaken with a further 1·5 l. of ethyl acetate. The lower, aqueous phase was discarded and the upper phase reduced *in vacuo* to a few ml. The extract was transferred to two 15 cm.-wide strips of acid-washed Whatman No. 1 chromatogram paper and these and another chromatogram with known gibberellic acid were developed simultaneously in the same tank using a descending solvent system consisting of the upper phase of a mixture of *n*-butanol/1·5 *N* ammonia (3 : 1). Each paper was removed when the solvent front had advanced 30 cm. from the starting line. The R_F value of gibberellic acid, detected by its ultra-violet fluorescence after spraying the comparison chromatogram with a mixture of 60 per cent ethanol, 40 per cent concentrated sulphuric acid, was found to be 0·22. The two chromatograms carrying the plant extract showed bands which fluoresced in ultra-violet. These bands were matched and the chromatograms cut into strips 3 cm. wide. The strips were eluted with acetone and the eluates dried in a current of air. The solid residue was taken up in a mixture of 0·5 ml. acetone, 2·5 ml. water. The solutions thus obtained were assayed as described above. The results are summarized in Fig. 2. Activity was shown in two strips corresponding to R_F 0·6–0·8. By comparison with a standard gibberellic acid bioassay the activity shown by the total extract is the same as that given by 15·2 µgm. This is equivalent to 0·021 p.p.m. fresh weight of peas.

Recently it has been demonstrated[9] that gibberellin A_1 occurs in seeds of *Phaseolus multiflorus*. Using the solvent system described above the R_F values[1] of gibberellins A_1 and A_2 as well as that of indoleacetic acid (McComb, unpublished) are of the same order as

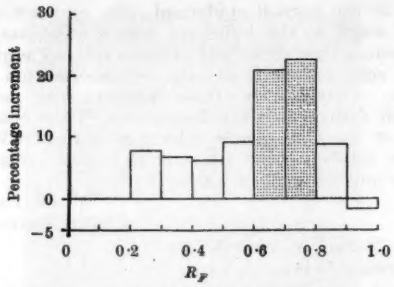

Fig. 2. Bioassay of extract of Telephone pea plants. Growth expressed as percentage increment. No assay from R_F 0·0 to R_F 0·2

that of gibberellic acid. The gibberellin-like activity of the extract of growing peas therefore cannot be attributed to any of these compounds. The activity cannot be attributed to adenine which has an R_F value in the system described above of 0·45. Also, adenine was found to have no effect at 4·2 μgm. per plant in the bioassay.

We are indebted to the Nuffield Foundation for a grant which provided some of the facilities for this work.

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Detection of Viable Air-borne Spores in Air

A simple method for trapping air-borne spores has recently proved useful for studying dispersal of the conifer pathogen *Fomes annosus*.

Pieces of muslin 20 cm. square are folded and placed in transparent 'self-sealing' envelopes: these are dry-sterilized at 100° C. and stored until required. To collect a sample of air spora, a muslin square is withdrawn from an envelope and attached to a wire frame, previously swabbed with 95 per cent alcohol, by means of a paper clip ('Bulldog' type) at each corner. The frame is fitted into a suitable holder so that the muslin faces squarely into the wind, supported behind by cross-wires. Static exposures are made in any open situation about 2 m. above ground, but exposures may also be made from a moving vehicle. The muslin is exposed for a period varying from a few minutes to several hours, depending on conditions, and is then folded and returned to the envelope, which is re-sealed. The catch is estimated by cutting a 10-cm. square from the centre of the muslin, transferring it to a screw-cap bottle and shaking with 20 ml. sterile water for 2 min. After compressing the material to remove excess water, the suspension and suitable ten-fold dilutions are plated with malt agar to estimate mould spores and are transferred to sections of freshly cut pine stem[1], to detect *F. annosus* and also *Peniophora gigantea*, an important competitor of the former in stumps.

By this method the two species have been detected at many localities in Great Britain. Of 50 exposures made well outside forest areas, 45 yielded *P. gigantea* and 33 *F. annosus*, showing that both are regular components of the air spora. When several exposures are made at one place the size of catch of these fungi depends to some extent on wind direction, presumably because spore production tends to be localized in conifer plantations. In certain circumstances, by making exposures some distance away, it has been possible to demonstrate the presence of *F. annosus* in forests from which it had not previously been reported. A successful exposure made about 30 miles from land on the Irish Sea first indicated that viable spores of this fungus may be carried considerable distances.

In its present form the method has certain disadvantages for quantitative work; for example, catch varies greatly with wind strength and probably with the degree of turbulence, and cannot be related to the volume of air sampled or to the total air spora. On the other hand, it is fortunate for the purpose of the present investigation that under a wide range of conditions there is good agreement between rate of catch and rate of spore deposition on a freshly cut, horizontal wood surface. If a similar relation exists with rate of spore deposition on leaves, for example, the method may be capable of wider application. Since under fairly uniform conditions the number of spores trapped is proportional to time of exposure, rate of catch may be expressed as viable spores/100 cm.²/hr. With moulds, this rate often lies in the range 200–600 for inland exposures made in winter. *F. annosus* spores have been trapped at the following rates under roughly comparable conditions at various distances from the respective nearest sources (not necessarily of comparable magnitude): 30 at 1 mile; 3 at 5 miles and 0·3 at 80 miles.

Grateful acknowledgment is made to all those assisting in the investigation.

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Silicification of Bulliform Cells in Grasses

Some of the opal phytoliths in the fine sand fractions of certain British soils have been traced to the grasses *Sieglingia decumbens* and *Molinia caerulea*[1] and it now appears that the largest of these arise in the bulliform cells of these species. As obtained from the soil or in residues prepared from the leaves, they appeared with fan-shaped outlines (Fig. 1), or with rectangular outlines, rather tabular but thinning to one edge, their surfaces often carrying one or two parallel ribs (Fig. 2). Using methods previously described[2], we have observed similar bodies *in situ* in the bulliform cells of *Chusquea culeou* (Figs. 3–6) and *Brachypodium pinnatum*. The arrangement of bulliform cells resembles in many ways the architecture of a long semicircular arch (Fig. 7), the upper blocks having the broadest and most fan-like section (*A*, *A'*). In the plant the units (that is, the cells) are unequal and the long ones may be pressed out as ribs at each junction between units in the next row

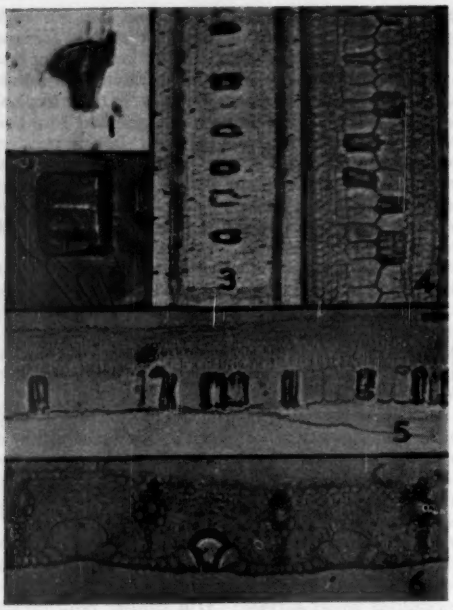

Fig. 1. Fan-shaped opal in *Sieglingia decumbens* (× 145). Fig. 2. Rectangular opal in *Molinia caerulea* (× 325). Figs. 3–6. *Chusquea culeou*. Figs. 3 and 4. Surface views (× 85) (× 130). Fig. 5. Longitudinal section (× 120). Fig. 6. Transverse section (× 120)

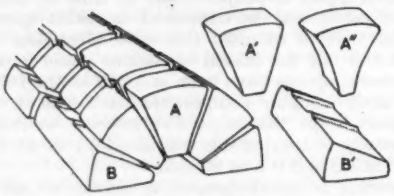

Fig. 7. Generalized architectural representation of the bulliform cells in grass leaf

(*B*, *B'*). As it is unusual for adjacent cells to be silicified, the phytolith surfaces may be curved due to the bulging of neighbouring cells (Figs. 1, 6, 7*A''*).

Various functions have been attributed to these cells. According to Esau[3], they are mainly concerned with the unrolling of the developing leaves, hence the alternative terms 'expansion cells' or 'motor cells'. Other possible functions are related to the hygroscopic opening and closing of mature leaves[4] and water storage[5]. There is also difference of opinion concerning their structure. Duval-Jouve[6], Eames and McDaniels[4], Haberlandt[7] and Esau[3] agree that these cells are large, thin walled and almost or completely lacking in solid organic content. Grob[8], however, although in agreement on this point, notes an abundance of intracellular silica in the bulliform cells of *Oryza sativa*, *Olyra latifolia* and *Olyra micrantha*, possibly indicating a change of function during the growth of the blade. The presence of silica in relatively large quantities in the bulliform cells of some of our British grasses suggests that this phenomenon is commoner than has been thought. Such depositions in the bulliform cells must completely upset their hygroscopic and water storage functions and might be an initial cause of the desiccation of the leaf. In the developing leaves, deposits of silica occur only in the normal epidermal cells, and not until a later stage do the bulliform cells accumulate silica, suggesting that when leaf expansion is accomplished, such cells can then become repositories for excess silica. Alternatively, these deposits may act in a similar fashion to the silicifications in the epidermal cells of the Cyperaceae, which according to Westermaier (Haberlandt[9]) prevent the total collapse of these cells at times of wilting.

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Fixation of Bacteria for Electron Microscopy

A recent communication[1] reporting that potassium permanganate yields an excellent fixation of vaccinia virus particles prompts me to point out that this fixative is equally satisfactory for some bacteria.

Fixation of bacteria with the buffered osmium tetroxide solution, commonly employed for animal tissues, has for some time been regarded as unsatisfactory for electron microscopy[2]. In particular the nuclear cavity and contents are poorly preserved. On the other hand, fixation in a buffered solution of potassium permanganate (1 per cent in a veronal–acetate buffer *p*H 7·2 for 1–2 hr.), a fixative devised by Luft[3], followed by embedding in an Araldite resin[4], gives a much more compact and pleasing appearance.

Fig. 1 is an electron micrograph of a section of *E. coli* prepared in this way. The nuclear cavity is well defined and its contents possess a fine-grained fibrillar texture quite different from the coarsely fibrillar structure noted after osmium fixation. If a preparation fixed in permanganate is given a subsequent treatment in an osmium tetroxide solution, the compact appearance shown in Fig. 1 is broken up and coarser filaments appear. Although the boundary between cytoplasm and nucleus is sharp (as seen in Fig. 1), no nuclear membrane has been seen.

The cytoplasm possesses a uniform fine-grained particulate texture and occasional inclusions have been noted. The capsule is usually somewhat lifted from the cytoplasm; this is probably an artefact produced during embedding.

We are using this method of fixation and embedding in a study of the relation between bacteriophage and bacteria, and find that the preservation of the bacteriophage is equally good. Fig. 2 shows a section of a cell, from the peripheral zone of a *T2* plaque, which contains many *T2* particles. The head membranes and tails are not stained by permanganate; only the hexagonal shaped head consisting of nucleic

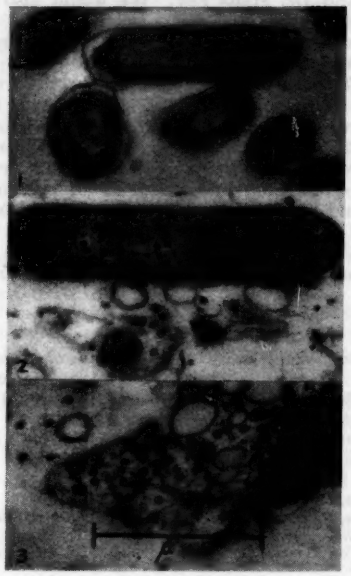

Fig. 1. Electron micrograph of a thin section of *E. coli* fixed in 1 per cent potassium permanganate for 1 hr. and embedded in 'Araldite' at 90° C. Fig. 2. *E. coli* infected with T2. Only the heads of the bacteriophage containing nucleic acid are seen. They are surrounded by a clear space occupied by the unstained head membrane. Surrounding the bacterium are seen bacteriophage and debris resulting from adjacent 'burst'. Fig. 3. A similar preparation to that shown in Fig. 2 but with the infection more advanced. Stained after fixation by means of 1 per cent phosphotungstic acid in 70 per cent alcohol. The head membranes and tails are now visible

acid is seen surrounded by a clear space. The head membrane and tail can, however, be stained by a subsequent treatment with phosphotungstic acid (Fig. 3).

The bacterial preparations used in this work have been very kindly provided by Miss Jocelyn Stock.

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Distribution of Electrophoretically Different Hæmoglobins among Some Cattle Breeds of Europe and Africa

Two hæmoglobins, *A* and *B*, can be distinguished in the blood of cattle by means of paper electrophoresis[1,2]. It has been shown that the presence or absence of the hæmoglobins is determined by two allelic autosomal genes which are fully expressed in the heterozygote[1]. The three phenotypes, bovine *A* (slow moving in electrophoresis), bovine *B* (fast moving component in electrophoresis), and bovine *AB* (both hæmoglobins present), have been found. In a previous study[1], it was shown that among British breeds, only Jerseys, Guernseys and South Devons possessed the *B* hæmoglobin.

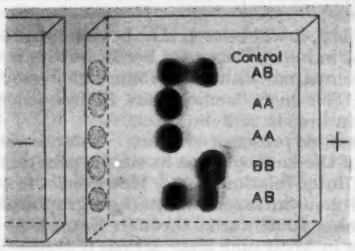

Fig. 1

One of the suggested ancestral lines of the Jersey breed was outlined by Boston[3] on the basis of archæological and other evidence, and led from the ancient Indus Valley civilization through Africa to Europe. Using the presence of bovine *B* hæmoglobin in a breed of cattle as a marker of common ancestry with Jersey cattle, as many breeds as possible were examined which were living on or near this geographical line.

Ford[4] has defined polymorphism as ". . . the occurrence together in the same habitat of two or more discontinuous forms of a species in such proportions that the rarest of them cannot be maintained merely by recurrent mutation". The existence in certain cattle breeds of these two forms of hæmoglobin fits within this definition and suggests that some selective factors and especially factors favouring the heterozygote may be operating under natural conditions or under those of man-controlled breeding. No such selective factors have yet been confirmed, although in the present study a possible association with lack of tolerance to trypanosomiasis in some African breeds has been noted.

The hæmoglobins were detected by a modification of the starch gel electrophoresis method of Smithies[5]. A drop of blood, collected from the jugular vein or by ear puncture, was placed on a 2-in. circle of Whatman filter paper, No. 1 or 3, and, when dry, forwarded by air to the laboratory in England. On arrival, 5 mm. circles of the dried blood were punched out of the filter paper and inserted into the starting slit of the starch gel. Borate buffer *p*H 8·0, ionic strength 0·16, was used for the preparation of the gel and borate buffer *p*H 8·6 was used in the electrode bath solution. Readings were made 4 hr. later, and provided that a control sample of polymorphic hæmoglobin was included in all runs, excellent identification of hæmoglobin was possible on dried samples up to one month old (Fig. 1). Identifications using this method were checked against determinations on whole blood

Table 1. THE DISTRIBUTION OF HÆMOGLOBIN GENOTYPES IN THE POLYMORPHIC EUROPEAN AND AFRICAN CATTLE BREEDS

Location	Breed	Genotype		
		AA	*AB*	*BB*
Jersey	Jersey	32	77	73
N. France	Brittany Shorthorn	0	2	0
N. France	Flamande	8	1	0
Mid France	Limousine	13	6	0
Mid France	Charolais	9	1	0
Mid France	Parthenaise	10	2	0
S. France	Salers and Aubrac	10	5	0
S. France	Garronaise	2	1	0
S.E. France	Tarentaise	9	1	0
S.E. France, Switzerland	Brown Swiss	24	9	0
W. Africa : Nigeria	Zebu (White Fulani)*	30	17	2
E. Africa : Sudan	Zebu*	13	29	10

* Low tolerance to trypanosomiasis infection.

using paper electrophoresis[1] and were found to be consistent.

In Table 1, it will be seen that bovine *B* hæmoglobin is present in many European herds, but its frequency is low compared with that found in Jersey Island Cattle. The high hæmoglobin *B* frequency again appears in breeds of Zebu stock.

The possible presence of selective factors may affect the use of the hæmoglobins as simple genetic markers of breed inter-relationships. However, the presence of the *B* gene in breeds located geographically on a line running southwards through France, and again in breeds in West and East Africa, is consistent with at least one of Boston's suggested[3] geneological lines of the Jersey breed. As it is probable that hæmoglobins bovine *A* and *B* are similar to the two described by Cabannes and Serain[2], there is yet further evidence of the *B* gene in Africa, although in this case it may have been imported into Algeria by Europeans through the medium of French breeds. On the other hand, and in view of the apparent mode of inheritance of the hæmoglobin genes, it is improbable that the cattle breeds of north-east France, Holland and Denmark have in recent times received any genes from the cattle of Jersey, central and southern France, or of cattle of Zebu stock (Table 2).

Table 2. Numbers of Animals examined in Breeds exclusively Bovine Hæmoglobin *A*

Location	Breed	No.
Europe		
Denmark	Danish Red	21
Holland	Friesians	35*
N. France	Normande	29
Africa		
Nigeria	Muturu†	50
Nigeria	N'Dama†	50

* From the table published by Bangham (ref. 1).
† High tolerance to trypanosomiasis infection.

Although little is known of the nature or tolerance of cattle breeds to trypanosomal infection, there is evidence that N'Dama and Muturu[5] have a greater tolerance to the disease than do the White Fulani (Zebu) cattle[7]. This receives further support from the quantitative studies of Desowitz[8], on the immune reactions of N'Dama and Zebu breeds to trypanosomal infections.

The present study shows a *prima facie* correlation between the absence of bovine *B* hæmoglobin and relatively high tolerance to trypanosomiasis (see Tables 1 and 2) and assumes some interest when related to the work of Allison on the presence of sickle cell hæmoglobin and resistance to falciparum malaria in man[9]. In order to determine if this is more than coincidence, it will be necessary to study, first, other breeds in the same environment; second, the relationship between the hæmoglobin phenotypes and tolerance to disease in members of the African breed; and third, breeds presumably related to the Zebu in areas remote from trypanosomiasis exposure. It has recently been shown that Nigerian White Fulani (Zebu) cattle are polymorphic for the genetically determined milk proteins *B*-lactoglobulin *A* and *B*, as are some European breeds, and that they are the only breed so far studied to have two types of α-lactalbumin, which may also be genetically determined[10]. A parallel study of the distribution of these proteins may help in the problems outlined.

It is with pleasure that we acknowledge the help given by Mr. N. le Q. Blampied, Mr. C. D. Cooke, Dr. M. Theret, A. A. Karib, H. K. Littlewood, A. G. Wilder and Dr. Hans Fey. We would also like to thank those breeders and owners who so readily offered material for this survey; for the loyal and patient technical help of A. Bernard; and for the invaluable help of O. Oyefeso in the field work in Nigeria. Prof. B. G. T. Elmes, University College, Ibadan, was instrumental in arranging for the collections in Nigeria. The investigations in Nigeria were supported in part by a research grant from the Wenner-Gren Foundation for Anthropological Research and by a Research Grant, *H*–3161, from the National Heart Institute, U.S. Public Health Service. A grant was made to one of us (A. D. B.) by the Agricultural Research Council for visits to France.

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A New Subterranean Crustacean from the West Indies

Recently I had to establish a new order Spelaeogriphacea in the division Peracarida for a small cavernicolous crustacean from Table Mountain, South Africa[1]. Now Dr. L. B. Holthuis, of the Leyden Museum, has sent me for study three specimens of another interesting new subterranean 'shrimp' which he collected on February 10, 1957, in Devil's Hole, near Simon's Bay, St. Martin, Lesser Antilles. This is a wide sink-hole, about 5 m. deep, in a limestone slope some 300 m. from the sea. From the hole itself a few short, blind passages run inwards; the specimens were caught in a tiny pool of mesohaline brackish water in one of these passages. A film of limestone particles covered most of the surface of the pool and a limestone sediment made the water turbid when stirred. Two days later, from the same pool, only some amphipods and nematodes were obtained.

The largest specimen, the holotype, is 9 mm. in length and the slender, rather vermiform body is flattened dorso-ventrally. The carapace is firmly fused dorsally with the tergites of the four anterior thoracic somites, and does not overlap the fifth (first free) somite (Fig. 1). On either side of the minute median apex the anterior margin is slightly oblique and concave; in front of each concavity is a short, broad ocular scale without trace of pigment or visual elements (Fig. 1, *oc*). Behind the carapace the body is fully segmented; it is widest across abdominal somite 3, and abdominal somites 4 and 5 are longest and equal. The telson is almost as wide as long and the posterior margin is armed with two lateral groups,

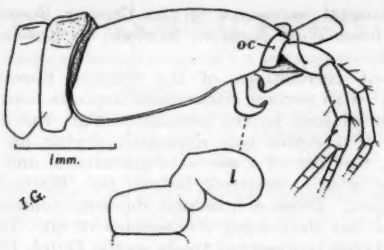

Fig. 1. *Rhopalonurus holthuisi* n.g. and sp. paratype. Anterior part of body, lateral aspect; scale = 1 mm. *l*, Lappet of lower lip; *oc*, ocular scale

each of three stout spines, and a strong median spine flanked by a pair of smaller spines (the latter group is visible in Fig. 2). The anus is an elongated slit on the ventral surface of the telson.

The antennules are much more robust, and rather longer, than the antennæ; the antennular flagella are only slightly unequal, the shorter about as long as the carapace; the antennal scale is minute and the two distal segments of the peduncle are long and slender. The upper lip, shown almost in profile in Fig. 1, is broadly triangular with rounded apex; each half of the lower lip has a large, oval, forwardly directed lappet (Fig. 1, *l*, in profile and in ventral aspect at higher magnification). The mouthparts, though similar to those of certain Mysidacea, have some unusual features. The minute third segment of the mandibular palp bears seven long spines; the incisor process is strong but the molar process is a small round knob; between the two is a strong triangular lobe and a short spine row. The maxillula is large and robust with a very long stout spine on the major endite and no reflexed palp (endopod). The pediform maxilliped has, in addition to the large backwardly directed epipodite, a small oval one (respiratory ?).

Each of the thoracic appendages 2–8 has a large natatory exopod, rather similar to those of the Mysidacea, and no epipodite. The three anterior pairs have their endopods directed forwards, much more robust than, and obviously differing in function from, those of the four posterior pairs which are slender ambulatories. They probably assist in the capture of food. The five pairs of pleopods are similar in size and form, each comprising a short protopodite, a one-segmented endopod and a three-segmented exopod. The protopodites of the third, fourth and fifth pairs respectively are united by a broad thin membranous flap (Fig. 2, *m*). The uropod is undoubtedly the most distinctive character of this species. The protopodite is broad so that its base occupies almost half of the posterior ventral margin of the sixth abdominal somite (Fig. 2) and, in addition, it has a stout backward prolongation (*p*) armed with five strong curved apical and subapical spines. The leaf-like exopod (*e*) and endopod are of equal length; in dorsal aspect their long marginal setæ (omitted in Fig. 2) conceal the spines of the prolongation *p*. Because of the unusual form of the uropod, I propose to call this small crustacean *Rhopalonurus holthuisi* gen. et sp. nov.

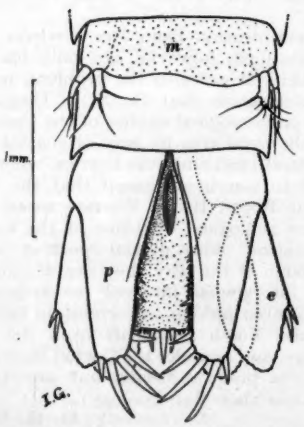

Fig. 2. *Rhopalonurus holthuisi* n.g. and sp. holotype. Posterior part of body, ventral aspect; scale = 1 mm. *m*, Membrane uniting bases of pleopods 5; *e*, exopod; *p*, prolongation of base of uropod

The holotype appears to be a female with four pairs of developing oostegites arising from the coxæ of thoracic limbs 4–7, so I assume that there must be a peracaridan brood-pouch. But the combination of characters found in *Rhopalonurus* is such that it cannot be placed in any of the known orders of the Peracarida as at present defined. It seems to be most nearly related to the Mysidacea but it is certainly not a mysid. The Tanaidacea have lappets on the lower lip, though they are very much smaller. The curious backward prolongation of the protopodite of the uropod, the broad telson and the number of free thoracic somites suggest affinities with the Stomatopoda, but these resemblances to mantis shrimps are probably superficial. The membranous flaps uniting the three posterior pairs of pleopods recall those of the thoracic swimming appendages of Copepoda. I hope to publish a fully illustrated description of *Rhopalonurus* in due course and shall then discuss its affinities in detail.

ISABELLA GORDON

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[1] *Bull. Brit. Mus. (Nat. Hist.), Zool.*, **5** (2), 29 (1957).

Koutekite: a New Mineral

WHILE studying specimens from Černý Důl in Krkonoše (Giant Mountains), Bohemia, a new mineral of composition Cu_2As has been found in the bicarbonate gangue together with arsenic, silver, smaltite, löllingite, chalcocite and other minerals. This new mineral has been found under the microscope in the form of fine grains, which occur in intergrowth with another copper arsenide, to be designated for the time being as mineral *X*. Mineral *X* forms edges around aggregates of arsenic and markedly displaces them.

By synthesizing alloys with varying copper/arsenic ratios it was possible to obtain a product corresponding very nearly with the formula Cu_2As. The synthetic product was identical with the new mineral under microscopic and X-ray examination.

Under the microscope Cu_2As appears bluish-grey (in comparison with chalcocite it has a marked bluish tinge). No internal reflexions could be observed even when using oil immersion. Koutekite is strongly anisotropic. Etching tests were positive with nitric acid (1 : 1); hydrochloric acid (1 : 1); 20 per cent ferric chloride; 5 per cent mercuric chloride gave partly positive and partly negative results; 40 per cent potassium hydroxide gave negative results. After short etching with nitric or hydrochloric acids

or ferric chloride the mineral changes to a crimson colour; after prolonged etching it becomes light grey. Koutekite has a strongly lamellar structure. The density of the synthetic Cu_5As measured hydrostatically is 8·48. Strong reflexions on the X-ray powder pattern have the following *d*-spacings: 3·32; 2·446; 2·078; 2·024; 1·994; 1·374; 1·324; 1·197; 1·178 and 1·147 A. On the basis of a number of attempts to index the X-ray powder pattern of the mineral, its symmetry appears to be hexagonal. The new mineral has been named koutekite in honour of Academician J. Koutek, professor of economic geology, Charles University, Prague.

Results of a detailed investigation of koutekite will be published elsewhere.

Zdeněk Johan

Department of Mineralogy,
Charles University,
Prague. March 31.

The Cromerian Interglacial

Prof. P. G. H. Boswell[1] has recently asked the question "Is the Cromer Forest Bed preglacial or interglacial?" and he states that it is premature to assign the Cromer Forest Bed to the oldest interglacial in East Anglia.

The crux of the problem appears to be one of nomenclature. If the term 'interglacial' is used in a descriptive stratigraphical sense, any non-glacial deposit between two glacial deposits may be called interglacial. Likewise, a preglacial deposit will lie below the oldest glacial deposits of the area concerned. In this stratigraphical sense the Cromer Forest Bed Series is preglacial, as Prof. Boswell rightly points out.

However, 'interglacial' has now acquired by usage a climatic as well as a stratigraphical meaning. The systematic application of pollen-analysis to interglacial deposits in many parts of western Europe, supplemented by identification of larger remains of plants and animals, has shown that the temperate interglacial stages can be recognized and characterized at least as precisely as the deposits of the intervening glacial stages. Such interglacial deposits commonly consist of organic muds or peats of substantial thickness: they consistently display a vegetational and faunistic sequence indicating amelioration of climate from arctic or boreal at the base, through conditions of increasing warmth capable of supporting temperate deciduous forest, to a final stage of revertence to cold conditions. In amplitude of climatic shift they resemble the changes from the end of the last glaciation through the Post-glacial thermal maximum, and they must have had a duration of similar magnitude, that is to say, a few ten thousands of years.

At Hoxne it has already been demonstrated that an interglacial of this kind lies between the tills of the Lowestoft and Gipping glaciations and the Bobbitshole, Ipswich, deposits referred to by Prof. Boswell, are of similar interglacial character though post-dating the Gipping glaciation. A precisely similar pattern of climatic change has been now demonstrated for the Cromer Forest Bed Series. These changes were first indicated in P. W. Thomson's pollen analyses published by Woldstedt[2], but they have been fully substantiated by extensive unpublished palynological research by Dr. S. L. Duigan[3] (now of the Department of Botany, Melbourne) upon coastal exposures of the Cromer Forest Bed Series from West Runton, Norfolk, to Kessingland, Suffolk.

Recent correlations of the Cromer Forest Bed Series[4,5] with certain continental deposits considered interglacial lead to the conclusion that the Cromer Forest Bed Series was deposited during an interglacial, the last of a series of glaciations and interglacials which occurred before the Elster/Mindel glaciation. These continental deposits contain substantial but decreasing frequencies of the Tertiary pollen types represented freely in the Dutch Pliocene deposits (Reuverian), and it is to be noted that both Thomson and Duigan emphasize the poverty of these types in the Cromer Forest Bed.

The Crag deposits themselves have not yet been investigated intensively by modern methods, and it seems to us possible that they may yet prove to include deposits which in a time-stratigraphical sense are glacial or interglacial in status.

Meanwhile, there seems a strong case for accepting the Cromer Forest Bed Series as the oldest of the known interglacial horizons[5] in East Anglia.

R. G. West
H. Godwin

University Sub-Department of
Quaternary Research,
Cambridge.
April 20.

[1] Boswell, P. G. H., *Nature*, **181**, 1087 (1958).
[2] Woldstedt, P., *Nature*, **165**, 1002 (1950).
[3] Duigan, S. L., Ph.D. Dissertation, University Library, Cambridge (1954).
[4] Zagwijn, W. H., "Geologie en Mijnbouw", N.S., 19e Jaarg. No. 7, 283 (1957).
[5] West, R. G., *J. Glaciology*, **3**, 211 (1958).

We must not be tempted at the moment, I think, into a discussion of the meaning and implications of 'interglacial'—a matter which now seems to be running full circle. The purpose of my communication was not to state a case for the preglacial age or other age of the Cromer Forest Bed, but to prevent a brief and easily quotable statement to the effect that "it was formed in the oldest interglacial period in East Anglia" (or, for that matter, a title like that of their present communication) being copied from paper to text-book and book to paper without mention of the fact that other evidence does not support the statement.

The communication from Drs. Godwin and West may be welcomed, however, not only for the additional publicity it gives to the problem, but also for the new information that Dr. S. L. Duigan has extended her palynological studies of the Cromer Forest Bed from the type area by way of coastal exposures to Kessingland (and thus via Corton, where Clement Reid failed to convince himself that the peaty bed was the true Forest Bed). We now await still more keenly some geological evidence of the existence of the palynologists' oldest glacial epoch in East Anglia and knowledge of the way they are dealing with the important interglacial interval (so striking in the field but so often hidden in correlation tables) which separates the North Sea Drift from the Lowestoft Boulder Clay, and includes the Corton Beds, Billockby fauna, etc. (a post-Cromerian but pre-Hoxnian interval, to use their terminology).

P. G. H. Boswell
Imperial College of Science and Technology,
London, S.W.7.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, June 2

INSTITUTE OF BIOLOGY—(at the French Institute, Queensberry Place, London, S.W.7), at 5 p.m.—Dr. Jacques Monod (Institut Pasteur, Paris): "The Permeases: Specific Factors of Cellular Permeability" (First Louis Rapkine Memorial Lecture).

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Council Room (second floor) of the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 5.30 p.m.—Dr. H. D. Anthony: "Scientific Literature and the Classification of the Sciences".

Tuesday, June 3

BONE AND TOOTH SOCIETY (at the Institute of Orthopædics, 234 Great Portland Street, London, W.1), at 5 p.m.—Annual General Meeting, followed by Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Prof. R. King: "Faraday and the Beginning of Useful Electricity". (Lecture for Fourth Form Pupils from Schools in London and the Home Counties. To be repeated on June 5, 10 and 12, at 5.30 p.m.)

Wednesday, June 4

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. C. J. Hughes: "The Southern Mountains Igneous Complex, Isle of Rhum"; Dr. T. W. Gevers (University of the Witwatersrand): Colour films illustrating African geology.

UNIVERSITY OF LONDON (at the Institute of Diseases of the Chest, Brompton Hospital, Fulham Road, London, S.W.3), at 5 p.m.—Dr. P. J. Lawther: "Air Pollution and Disease".*

Thursday, June 5

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. G. E. Bacon and Mr. W. E. Gardner: "The Structure of Chromium Potassium Alum"; Mr. G. A. Bassett, Mr. J. W. Menter and Mr. D. W. Pashley: "Moiré Patterns on Electron Micrographs and their Application to the Study of Dislocations in Metals".

INSTITUTION OF NAVAL ARCHITECTS (in the Weir Lecture Hall, 10 Upper Belgrave Street, London, S.W.1), at 4.45 p.m.—Commdr. Pawsey, Mr. D. J. Doust and Mr. E. MacDonald: "Riding Qualities of Light Vessels".

CHEMICAL SOCIETY (in the Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 7.30 p.m.—Prof. L. Ruzicka: "The History of the Isoprene Rule".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

READER (with a degree of a British university, and research qualifications in some branch of applied mathematics or statistics) IN APPLIED MATHEMATICS—The Clerk to the Governing Body, Battersea College of Technology, London, S.W.11 (June 6).

RESEARCH ASSISTANTS (3) IN THE DEPARTMENT OF BOTANY AND ZOOLOGY—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (June 6).

UNIVERSITY LECTURER (preferably with qualifications in applied thermo-dynamics) IN MECHANICAL ENGINEERING at the University of Aberdeen and Robert Gordon's Colleges—The Secretary, The University, Aberdeen (June 6).

SENIOR LECTURER or LECTURER (with a first- or second-class honours degree in engineering, teaching experience, and preferably a specialist knowledge of structures, properties and materials or mechanics of fluids) IN CIVIL ENGINEERING at the Royal Military College of Science, Shrivenham—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E.173/8 (June 7).

TEXTILE CHEMIST (preferably with a university degree or Associate of the Royal Institute of Chemistry or other appropriate qualifications) AT THE CONDITIONING HOUSE, Bradford, for duties involving the chemical testing of textile materials of all types from fibre to finished products—The Town Clerk, Town Hall, Bradford, quoting "Textile Chemist" (June 7).

SCIENTIFIC OFFICERS (2) (with a first- or second-class honours degree in mathematics, physics, chemistry or biochemistry) AT THE WINDERMERE LABORATORY, for research on the influence of water movements and bottom deposits on the productivity of lakes (one for dynamic, and the other for (organic) chemical aspects)—The Director, Freshwater Biological Association, The Ferry House, Ambleside, Westmorland (June 9).

SENIOR FELLOW and a RESEARCH FELLOW IN THE DEPARTMENT OF MICROBIOLOGY, John Curtin School of Medical Research, Australian National University, Canberra, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 9).

UNIVERSITY DEMONSTRATOR (with an honours degree in botany or agricultural botany) IN AGRICULTURE—The Secretary, School of Agriculture, The University, Downing Street, Cambridge (June 11).

SENIOR LECTURER IN RADIOCHEMISTRY in the Department of Natural Philosophy—The Secretary, The University, Edinburgh (June 14).

TECHNICIAN (over 21 years of age, a sound general education, and preferably some experience in laboratory organization, in photography and/or microtechnique) IN THE DEPARTMENT OF BOTANY—The Registrar, University College of Swansea, Singleton Park, Swansea (June 14).

LECTURER IN PHYSICS, and a STAFF FELLOW IN NUCLEAR PHYSICS—The Registrar, The University, Birmingham 15 (June 16).

LECTURER (with special interests in psychometrics, statistics and educational psychology) IN EDUCATION—Prof. E. A. Peel, Head of the Department of Education, The University, Edmund Street, Birmingham 3 (June 16).

LECTURER or ASSISTANT LECTURER IN THE ELECTRONIC COMPUTATION LABORATORY—The Registrar, The University, Sheffield (June 21).

RESEARCH BIOCHEMIST (honours graduate in science with biochemistry as a major subject, and postgraduate research experience in muscle biochemistry or enzymology) on the Staff of the Division of Food Preservation and Transport, Commonwealth Scientific and Industrial Research Organization, Sydney, New South Wales, Australia, to play a leading part in fundamental investigations into biochemical properties of muscle, especially those which have a bearing on the quality of meat and changes which occur during chilling, freezing and storage—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 300/218 (June 21).

BRITISH PETROLEUM RESEARCH FELLOW IN THE DEPARTMENT OF CHEMISTRY—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (June 22).

ASSISTANT LECTURER IN PHILOSOPHY—The Secretary, University College, Gower Street, London, W.C.1 (June 30).

ASSISTANT LECTURER (man or woman) IN CHEMISTRY—The Principal, Royal Holloway College (University of London), Englefield Green, Surrey (June 30).

LECTURER (preferably familiar with the techniques of nuclear chemistry) IN THE DEPARTMENT OF CHEMISTRY, Victoria University of Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, June 30).

SCIENTIFIC OFFICER (with a good honours degree, and preferably two or three years postgraduate experience) IN THE ENTOMOLOGY DEPARTMENT, to work on some problems concerning the biology of forest soils—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting 1051/12 (June 30).

SENIOR LECTURER (preferably with overseas experience) IN PHYSICAL OR INORGANIC CHEMISTRY at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 30).

GEOLOGIST (with a degree in geology or equivalent, and a satisfactory knowledge of (*a*) petrology and mineralogy or (*b*) stratigraphy or palæontology) IN THE GEOLOGICAL SURVEY—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (July 1).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHILOSOPHY—The Registrar, University College of South Wales and Monmouthshire, Cathay's Park, Cardiff (July 4).

RESEARCH FELLOW (graduate in agriculture or in pure science with special training in agriculture) IN THE FACULTY OF AGRICULTURE, University College of Ghana, for work at Kpong, 50 to 60 miles from Accra, where a research station is being established, and to undertake laboratory and field studies, and to work out practical ways and means of soil management for production of economic crops—The Secretary, Inter-University Council for Higher Education Overseas 29 Woburn Square, London, W.C.1 (July 10).

SENIOR LECTURER (with postgraduate experience in a branch of animal nutrition, preferably in ruminant nutrition and intermediary metabolism) IN ANIMAL NUTRITION at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 12).

PROFESSOR OF GEOGRAPHY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 31).

PROFESSOR (with academic qualifications in arts, commerce or agriculture with special qualifications and experience in teaching or research in agricultural economics, or in any branch of economics as applied to agriculture) OF AGRICULTURAL ECONOMICS at Canterbury University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

AGRICULTURAL OFFICERS (women) (with a university degree in agriculture or horticulture with suitable postgraduate training in rural economics and teaching methods) IN THE DEPARTMENT OF AGRICULTURE, Uganda, to organize the teaching of agriculture to African women at various farm institutes throughout Uganda—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/9/032.

ASSISTANT (Grade "B") TO TEACH PHYSICS—The Principal, College of Technology, Queen Street South, Huddersfield.

ASSISTANT LECTURER, Grade "B" (with a good honours degree) in physics and interested in the application of physics in industry IN THE PHYSICS DEPARTMENT—The Principal, North Staffordshire Technical College, Stoke-on-Trent, Staffordshire.

FISHERIES RESEARCH OFFICER (with a good honours degree in zoology and at least two years suitable postgraduate research experience) with the East African Fisheries Research Organization, Jinja, Uganda, to undertake research in fish physiology and/or ecology; and a HYDROLOGIST (with a good honours degree in natural science, including chemistry, with postgraduate research experience in hydrology or the chemical analysis or bacteriology of freshwater)—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.195/194/04.

LECTURER/DEMONSTRATOR IN THE CHEMISTRY DEPARTMENT—The Bursar, Royal Agricultural College, Cirencester.

MATHEMATIC GENETICIST (with a first-class honours degree in science or higher qualifications, and research experience in some field of mathematical genetics) IN THE DIVISION OF PLANT INDUSTRY, Commonwealth Scientific and Industrial Research Organization, Canberra, to work on theoretical aspects of evolutionary genetics and plant breeding—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 130/359.

PLANT PHYSIOLOGIST (male, with a good honours degree in botany) or natural science, and two years suitable postgraduate training or

experience, preferably in plant physiology) AT THE WEST AFRICAN INSTITUTE FOR OIL PALM RESEARCH, Nigeria, to review methods of production and initiate ways of increasing the supply of palm wine—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.197/199/013.

RESEARCH ASSISTANT (honours graduate in chemistry, or approaching the final examination), to work on organo-compounds of boron or on related compounds—The Head of the Chemistry Department, Northern Polytechnic, Holloway, London, N.7.

RESEARCH ASSISTANTS IN PURE AND APPLIED CHEMISTRY (fields of study include inorganic chemistry, fuel technology, electrochemistry and physical chemistry)—Head of the Department of Applied Chemistry, Northampton College of Advanced Technology, St. John Street, London, E.C.1.

SENIOR TECHNICIAN (Grade I or Grade II), to assist with research work on clinical problems associated with electrolyte and allied disturbances—The House Governor, The Queen Elizabeth Hospital, Birmingham 15.

TECHNICIAN IN THE DEPARTMENT OF PATHOLOGY, University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Bulletin of the British Museum (Natural History). Entomology. Vol. 6, No. 7: A Contribution to the Taxonomy of *Stenoponia* J. & R. (1911), a Genus of Palaearctic and Nearctic Fleas. By Karl Jordan. Pp. 167–202. 10*s*. Vol. 6, No. 8: The Mealy-Bugs (*Pseudococcidae: Homoptera*) described by W. M. Maskell, R. Newstead, T. D. A. Cockerell and E. E. Green from the Ethiopian Region. By D. J. Williams. Pp. 203–236. 10*s*. Vol. 6, No. 9: Miss L. E. Cheesman's Expedition to New Hebrides, 1955. Orders Odonata, Neuroptera and Trichoptera. By D. E. Kimmins. Pp. 237–250. 5*s*. (London: British Museum (Natural History), 1958.) [123

Philosophical Transactions of the Royal Society of London. Section B: Biological Sciences. No. 680, Vol. 241 (13 March 1958): The Water Balance of Tsetse Pupae. By E. Bursell. Pp. 179–210+plate 10. (London: The Royal Society, 1958.) 12*s*. [123

United Kingdom Atomic Energy Authority: Research Group. Selected Abstracts of Atomic Energy Project Unclassified Report Literature in the Field of Radiation Chemistry and Bibliography of the published Literature, 1st Annual Supplement (Papers noted up to February 1957). Compiled by R. W. Clarke. Pp. iv+209. (A.E.R.E. C/R 1575 (1 to 6), Supplement 1.) (London: H.M. Stationery Office, 1957.) 28*s*. net. [133

Polish Cultural Institute. Selective Quarterly Guide to Polish Periodical Literature, Vol. 3, 1, 1958. Pp. 1+70. (London: Polish Cultural Institute, 1958.) [133

Ministry of Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for 1956. South Western Division. By T. A. Jones. Pp. ii+24+4 plates. (London: H.M. Stationery Office, 1958.) 2*s*. 6*d*. net. [133

Scotland. Western Regional Hospital Board: Regional Physics Department, Glasgow. Annual Report of the Regional Physicist for the year 1957. Pp. ii+27. (Glasgow: Western Regional Hospital Board, 1958.) [133

Organic Reagents for Metals. Monograph No. 33 (1957): Nitroso-R-Salt: Reagent for Cobalt and Iron. By R. J. Reynolds and P. Casapieri. Pp. 7. (Chadwell Heath: Hopkin and Williams, Ltd., 1957.) [143

British Museum (Natural History). Ruwenzori Expedition 1952. Vol. 1, No. 1: Introduction with List of Localities. By G. O. Evans and D. S. Fletcher. Pp. vii+2 plates. 2*s*. 6*d*. net. Vol. 1, Nos. 2–3: Arctiidae (except Nolinae), Thyretidae amd Notodontidae. By S. G. Kiriakoff. Pp. 1–54. 10*s*. 6*d*. net. Vol. 1, No. 4: Arctiidae, Nolinae. By D. S. Fletcher. Pp. 55–68. 3*s*. net. Vol. 1, No. 5: Lymantriidae. By C. L. Collenette. Pp. 69–76. 2*s*. net. Vol. 1, No. 6: Geometrodae. By D. S. Fletcher. Pp. 77–176. 21*s*. net. (London: British Museum (Natural History), 1958.) [143

The Carnegie United Kingdom Trust. Forty-fourth Annual Report, 1957. Pp. ix+59. (Dunfermline: Carnegie United Kingdom Trust, 1957.) [173

Government of Northern Ireland: Ministry of Agriculture. Leaflet No. 40: Grassland Husbandry. Pp. 28. Leaflet No. 101: The Making of Silage. Pp. 15. (Belfast: Ministry of Agriculture, 1958.) [173

The Education of Boys and Girls between the Ages of 15 and 18: Being a Memorandum prepared by the Association of Teachers in Technical Institutions. Pp. 14. Sandwich Courses. Pp. 13. (London: Association of Teachers in Technical Institutions, 1958.) [173

Building Research Station Digest No. 107 (February, 1958): Damp-proof Course Insertion. Pp. 6. (London: H.M. Stationery Office, 1958.) 3*d*. [173

Other Countries

Tropical Woods, No. 107 (October, 1957): International Glossary of Terms Used in Wood Anatomy. Pp. 36. (Zürich: International Association of Wood Anatomists, Universitätstrasse 2; New Haven, Conn.: Prof. William L. Stern, 205 Prospect Street, 1957.) [173

International Scientific Radio Union. Proceedings of the 12th General Assembly held in Boulder, Colorado, U.S.A. from August 22nd to September 5th, 1957. Vol. 11, Part 1: Commission 1—On Radio Measurements and Standards. Pp. 78. (Uccle-Bruxelle: International Scientific Radio Union, 1957.) 100 Belgian francs; 14*s*. 6*d*.; 2 dollars. [173

Tanap: Sbornik Prác o Tatranskom Národnom Parky, No. 1. (Sammlung von Studien Über den Tatra-National Park.) Pp. 110. (Tatranská Lomnica: Správa Tatranského národneho parku, 1957.) Cena Kev. 11, 20 broz. [113

United States Department of Agriculture Technical Bulletin No. 1167: The High Plains Grasshopper: a Compilation of Facts about Its Occurrence and Control. By Claude Wakeland. Pp. iv+168·1 dollar. Technical Bulletin No. 1173: A Taxonomic Revision of the Leafhopper Genus *Flexamia* and a New Related Genus (Homoptera, Cicadellidae). By David A. Young, Jr., and Bryan P. Beirne. Pp. ii+53. 25 cents. (Washington, D.C.: Government Printing Office, 1958.) [173

Bulletin of the American Museum of Natural History. Vol. 114, Article 2: Permian Gastropoda of the Southwestern United States. 2: Pleurotomariacea: Portlockiellidae, Phymatopleuridae, and Eotomariidae. By Prof. Roger Pyman Batten. Pp. 153–246+plates 32–42. (New York: American Museum of Natural History, 1958.) 3 dollars. [173

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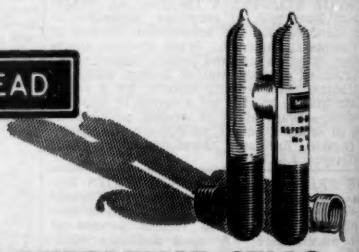

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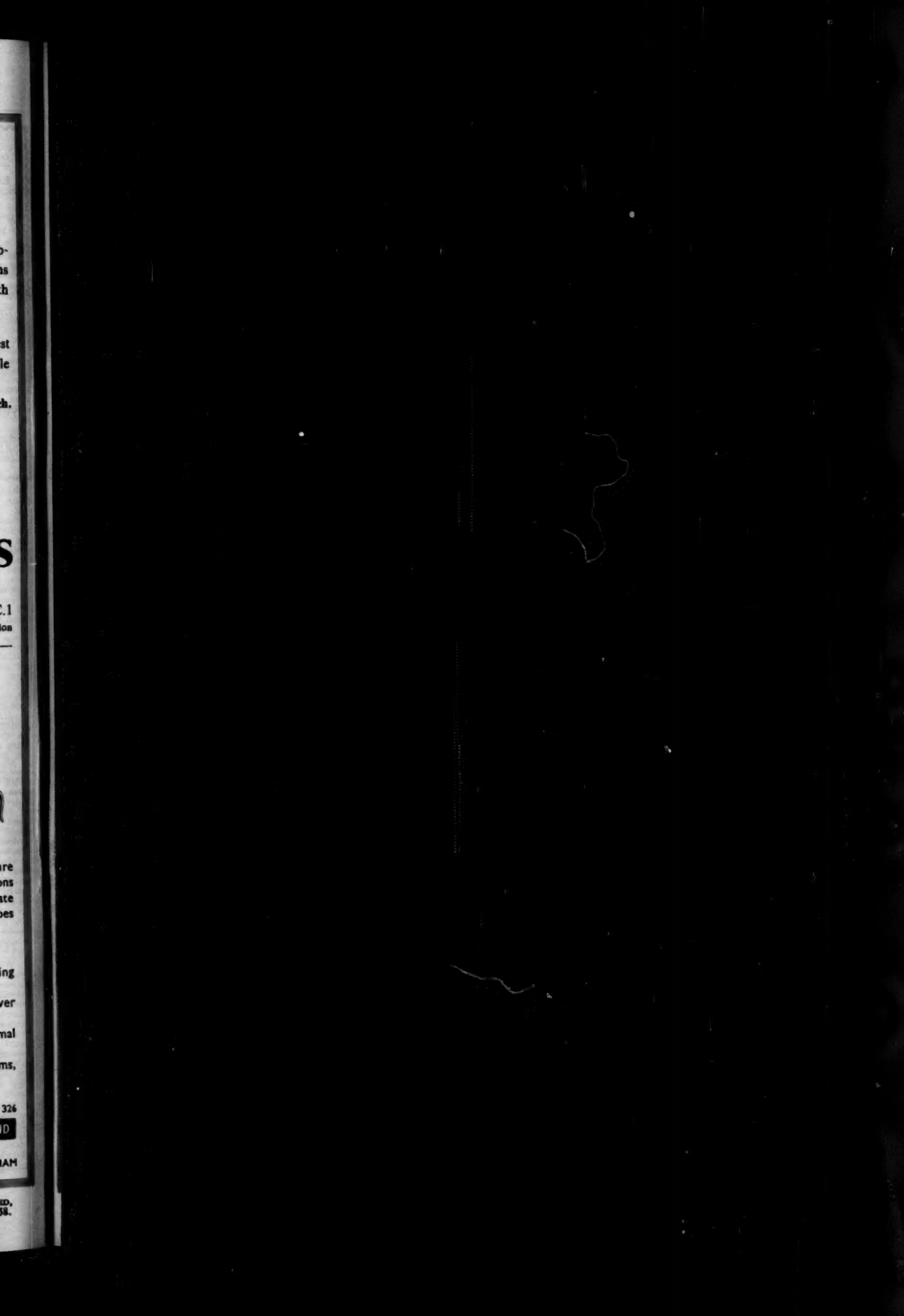
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